A LABORATORY MANUAL

IN

FARM MACHINERY

BY

FREDERICK A. WIRT, B.S.C.E.

Assistant Professor in Charge of Farm Machinery, Kansas State Agricultural College
Member American Society of Agricultural Engineers

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EDITED BY

L. W. CHASE, A.E., M.E.

Professor of Agricultural Engineering, University of Nebraska

AND

J. B. DAVIDSON, A.E.

Professor of Agricultural Engineering, University of California

A Farm Machinery Class in the Field.

Frontispiece.

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PREFACE

In preparing this manual the author has kept in mind the need of a laboratory guide that would not be affected to an appreciable extent by ordinary changes in farm machinery construction; that would be suitable for university students; and that would be so arranged that the questions asked would lead the students to draw their own conclusions as to which machines are best adapted to the various agricultural conditions.

The manual consists of three parts: Part One, Farm Field Machinery; Part Two, Power Farming Machinery; and Part Three, Farm Mechanics.

Part One, Farm Field Machinery, consists of those machines that are generally driven by horse power, but in order to comply with the usual practices in teaching some small machines that technically belong to Part Two have been included. These studies can be placed in four classifications: comparison, assembling, tests, and economics. A departure from the usual practice will be noticed in the arrangement of the comparison form of exercises. The outline which precedes the questions is included for the purpose of giving the student a good understanding of the methods of comparing different machines. The questions are grouped according to the natural subheads under which they come, with the emphasis on operation and adjustment rather than on construction. It was difficult to draw the line between questions on operation and on practical problems. In general the "Practical Problems" are better adapted to assignments of independent work. Many of the problems are based on data that can be obtained from Bulletin No. 3, "A Normal Day's Work for

Various Farm Operations," of the United States Department of Agriculture, consequently the problems are stated in very general terms. The table on page 100 of Part Two is taken from Bulletin No. 3.

Part Two, Power Farming Machinery, considers machinery pulled or driven by a mechanical motor. The exercises are similar in form to those in Part One.

Part Three, Farm Mechanics, is not intended to be a textbook on the subject, although it is hoped that the explanatory matter and figures will be sufficient to enable the student to perform the exercises with very little assistance, thus lightening the labor of the instructor.

The author is indebted to Professor W. W. Carlson and Mr. R. E. Wiseman of the Kansas State Agricultural College for many valuable suggestions in the preparation of Part Three; to more than fifty representatives of different manufacturing companies in the preparation of Parts One and Two; to Professor C. O. Reed, University of Illinois; to Professor A. H. Gilbert, Purdue University; and to Professor A. A. Potter, Dean of the Engineering Division, Kansas State Agricultural College.

The writer wishes especially to acknowledge the assistance of Professor L. W. Chase, University of Nebraska, and Professor J. B. Davidson, University of California, whose criticisms of the original manuscript led to important changes.

F. A. W.

MANHATTAN, KANSAS.

SUGGESTIONS TO TEACHERS

EACH of the three parts of the manual can be used for a separate course; or a combination of exercises from the three parts can be used for a general course in farm machinery. A course in machinery testing can be worked out with Exercises 4, 9, and 37 of Part One and Exercise 13 of Part Two as a basis. Economy tests go hand in hand with the cost of operation tests.

For the convenience of the teacher and the student, the exercises assigned can be listed on page 157, entitled Semester Assignment.

In the presentation of Farm Field Machinery and Power Farming Machinery, the exercises in Parts One and Two will be found readily adaptable to all methods. Exercises on testing and assembling usually require written reports. The comparison form of exercises such as Exercises 2, 7, and and 10 and others in Parts One and Two can be presented in several different ways: A written report can be required for each machine studied; or a written report for each group of machines; for example, the questions can be answered once when studying three plows; or have the students take an oral quiz on the exercise in lieu of a report.

Exercise 38, Field Observation, Part One, as indicated by the title, consists of observing and, when possible, of operating the machines in the field; either verbal or written reports can be required.

If the manual is used for high schools, schools of agriculture, and short courses, certain questions, problems, and exercises may be omitted. A combination recitation-lecture-demonstration for comparison exercises with a manual in the hands

The report is preferably written in ink on one side of $8\frac{1}{2}$ by 11-inch paper. The following outline must be followed in writing up the report:

Object: Discuss object of such an exercise.

Method: Give a detailed description of the method of procedure.

Apparatus: Describe briefly the apparatus and machinery used.

Data: The original data together with calculated results should be neatly tabulated.

Curves: Plot various curves which will bring out the important points of the experiment. Free-hand sketches are not advisable.

Results: *These should be set forth clearly and concisely.*

The above is the outline referred to in Exercises 3, 9, and 11 of Part One and in others.

The first sheet of the report should have the exercise number and section designation, in the upper right-hand corner. In about the center of the sheet should be placed on separate lines, (1) Name of student, (2) Title of exercise, (3) Date performed.

Comparison exercises such as Exercises 7, 10, 12, and 24 of Part One are treated differently. The outline which precedes the questions is given as a guide for comparing the machines. The machines should be studied first by this outline, then by taking up the questions. Only in this way can the construction of the different machines be mastered. It must be understood that only a comparatively few machines can be studied in school, yet it is necessary for every student to know how to compare machines in after years without the use of a set of questions. It should not be forgotten that there is a reason for every question asked.

When studying a machine the following essentials should always be kept in mind: Construction; operation; adjustment; selection; and uses. Ease of repairing and ease of manipulation come under operation and adjustment.

After the outline has been studied the report can be taken

up. The report may be written or oral. If the report is written the questions are to be answered once, unless otherwise directed by the instructor. If a different answer is required for each machine, place the answers on separate lines in the order in which the machines are named in answer to question No. 1. The answers are to be written in ink on $8\frac{1}{2}$ by 11-inch paper, each answer beginning at the left-hand margin of the paper. The title sheet is to be similar to the title sheet described below the general outline.

If the report is to be oral the student should not report to the instructor for the oral quiz until every question can be answered.

When specifications of machines are asked for, they should be given in the order of sequence of the subheads in those exercises.

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LABORATORY MANUAL IN FARM MACHINERY

PART I

FARM FIELD MACHINERY

EXERCISE 1

Walking Plows

EXAMINE walking plows, comparing the following: size; shape of moldboard; construction, function, and adjustment of frog, share, landside, moldboard, beam, handles, throat, and hitch.

REPORT

GENERAL INFORMATION

1. Give names and sizes of plows.
2. Give names and addresses of manufacturers.

FROG

3. What parts are fastened to the frog?
4. Which frog gives the best support to these parts?

SHARE

5. Why use slip shares? Bar shares?
6. What part of the share receives the greatest wear?
7. How is this part reinforced?
8. Why is there a bearing surface at the wing of the share?
9. Why does the amount of bearing surface differ on the different sizes of plow bottoms?
10. How can the share be removed for sharpening?

Landside

11. Classify plows examined as to height of landside. Classify as high those more than 5 inches; medium, 4 to 5 inches; low, less than 4 inches.
12. Describe reinforcement of landsides.
13. What purpose does the depth or vertical suction serve?
14. Why have land or horizontal suction?
15. What advantages has an adjustable heel?
16. What material is used in the heel and why is it used?

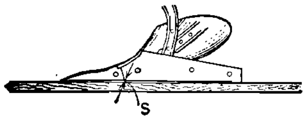
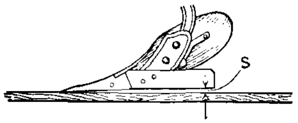


Fig. 1.



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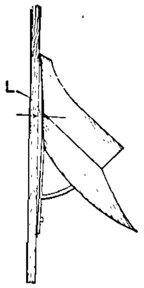

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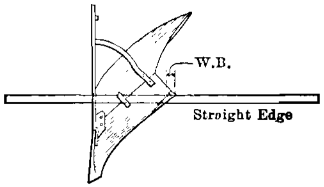


Fig. 4.

Plate I.—Fig. 1, Suction of a walking plow; Fig. 2, Suction of a Riding Plow; Fig. 3 Horizontal Suction; Fig. 4, Wing Bearing.

Moldboard

17. Give names of plows, materials used in construction, and kind of work to which each plow is especially adapted.
18. Explain methods of reinforcing.

Beams

19. Are wooden or steel beams used?
20. For how many horses are the beams landed?

21. Which plow has the greatest height of hitch? Which has the least?

22. What is the advantage in having a large throat? Classify plows studied as to size of throat.

23. How can depth and width of furrow slice be changed on the same plow?

OPERATION

24. Under what conditions should the suction and the bearing at the wing of the share be changed? How is this accomplished?

25. What will give a walking plow a tendency to tip over towards the plowed ground? The unplowed ground?

26. Under what condition will a plow run on its point?

Practical Problems

1. Give specifications for walking plows, including length of eveners to be used under the conditions noted below:

Farm A. Soil is of black loam free from rocks and slopes. Three horses are available.

Farm B. Land is hilly and the soil is full of gravel. Three horses are available.

Farm C. Land is hilly and the soil is a sandy loam. Two horses are available.

2. A two-horse team is used on a 12-inch walking plow and the land is plowed 5 inches deep. How many acres can be plowed in a day?

3. A three-horse team is used on a 16-inch walking plow and the land is plowed 7 inches deep. How many acres can be plowed in a day?

4. How long will it take to plow a forty-acre field if conditions are as in questions two and three?

5. A farmer is plowing 6 inches deep with a walking plow. A team of tall horses furnishes the power. If a team not so tall is used, but with traces of the same length, how must the cross clevis be adjusted to maintain the same depth of plowing?

6. If the traces are shortened considerably on the harness worn by a team pulling a walking plow, how must the cross clevis be adjusted to maintain the same depth of plowing?

7. How long a double-tree is necessary if (*a*) two horses are used on a 16-inch plow? (*b*) Three horses on a 14-inch plow, and (*c*) three horses on a 16-inch plow?

EXERCISE 2

Sulky and Gang Plows

Examine riding plows, comparing the following: size, shape of moldboard; method of guiding; construction, function, and adjustment of frame, bails, wheels, plow bottom, levers and hitch.

REPORT

General Information

1. Give names of plows.
2. Give names and addresses of manufacturers.
3. Tabulate: Size of plow, type of moldboard, and style of plow.

Wheels

4. How are wheels lubricated?
5. What provisions are made for keeping dirt out of wheel bearings?
6. Why are the furrow wheels inclined?

Frame

7. State which plows are frame or frameless? Tongue or tongueless?
8. Compare the plows as to strength of frame.

Levers

9. How many levers are there? Explain the use of each.
10. What advantages has the foot lift plow over the lever lift type?

11. How hign will each of these plows lift when plowing 6 inches deep?

12. Will the frame remain level under plowing conditions if the bottoms are raised with the foot lift?

Beams

13. Name plows having a single bail. Name the double bail plows.

14. Compare plows as to strength of beam.

Plow Bottoms

15. Tabulate materials used in the frogs, landsides, shares, and moldboards.

16. Explain placing and use of reinforcements.

17. Why can a shorter landside be used on a riding plow than on a walking plow?

Operation

18. Describe in detail the methods of lubricating all bearings.

19. Explain how the bottoms can be locked down or permitted to float.

20. Under what conditions is it advisable to set the plow to float?

21. How can the width of the furrow be changed?

22. In what manner can landside friction against the furrow wall be done away with or reduced to a minimum?

23. Describe methods used in changing the lead of the two furrow wheels.

24. How can side draft be reduced to a minimum?

25. In what way can the depth of the furrow be regulated?

26. When is it necessary to use a weed hook?

27. Discuss adjustment of coulters in sod, in stubble, in trashy ground and in very hard ground.

28. How can the operator make certain that the hitch in the vertical clevis is in the proper hole?

29. What determines the horizontal position of the hitch?

30. Compare convenience with which each plow can be turned either to right or left.

31. With the land wheel on a 6-inch block, and the plow leveled, adjust each plow so that there is $\frac{1}{2}$-inch of suction, no pressure on the landside, and the plow is cutting the proper width. Set the coulter for stubble ground supposed to be in good condition for plowing. Call the instructor to pass on your work.

Practical Problems

1. Give specifications for riding plows to be used under the conditions noted below:

    Farm A. Soil of black loam. Three horses are available.

    Farm B. Black loam soil. Four or six horses are available.

2. Three horses are used on a 16-inch sulky and the land is plowed 5 inches deep. How many acres can be plowed in a day?

3. Four horses are used on a 12-inch gang plow and the land is plowed 7 inches deep. How many acres can be plowed in a day?

4. On a 16-inch sulky, how far is the true line of draft from the center of the open furrow? How far is the point of hitch from the true line of draft?

5. With the length of traces and position of hame staple the same, what effect has the lowering of the hitch on the single-bail plow and the double-bail plow?

6. How must the vertical hitch be changed in going from soft to hard ground?

7. A plow does good work in the spring. In the fall it will hardly work, yet the adjustments are the same and the share is sharp. What is the cause?

8. Give each step in adjusting a plow in order of natural sequence.

9. Give your ideas of the comparative quality of work that can be done in a large field with a good walking plow and a high-grade sulky plow.

EXERCISE 3

Gang Plow Assembling

TAKE a gang plow apart, assemble, and report upon it as follows:

Taking Down: Remove parts in the following order: seat, coulters, weed hooks, levers, wheels, and frame. Leave them in such shape that the parts can be shipped. Be careful not to remove bail hangers.

Assembling: Consult the instructor before and after assembling. Put the plow together again in reverse order to that in which it was taken apart. Adjust it properly.

Report: Follow the general outline as given under the instructions. Be sure to include name of plow, name and address of manufacturer, and state time required for taking down and assembling.

EXERCISE 4

Draft Test of a Sulky Plow

THE plow should be properly adjusted before making the test. When plowing the first few rounds the different adjustments can be made in about the following order:

(*a*) Tongue;
(*b*) Furrow wheels;
(*c*) Hitch (horizontal and vertical);
(*d*) Width of furrow;
(*e*) Coulter or jointer.

1. On unplowed ground two students lay off a distance of 200 feet into 10 spaces by driving stakes 20 feet apart. These stakes are to be driven 8 or 10 feet from the open furrow.

2. Two students measure the width of furrow by measuring from the edge of the furrow to the stakes and then by subtracting the new distance after the plow has passed.

3. Two students measure the depth plowed by taking the distance between the bottom of the furrow and a straight

edge, one end of which (at least 3 feet) rests on the unplowed ground.

4. One student uses a stop watch to obtain the time required by the team to walk the 200 feet.

5. Other students read the indicating dynamometer when the plow is opposite each stake. If the recording dynamometer is used, one student attends to it.

6. Two students act as recorders. They record the draft readings as rapidly as the dynamometer is read and measure H_1, H_2, and L. (See paragraph 7.)

Readings for the zero stake are not used in obtaining averages.

7. Angle of hitch can be obtained by means of the expression,

$$\text{sine } A = \frac{H_1 - H_2}{L},$$

where A is angle of hitch;

H_1 is the average vertical distance from the cockeyes in the hames to the surface of the ground;

H_2 is the vertical distance from the point of hitch to the surface of the ground; and

L is the distance from the cockeyes to the hitch.

8. After each trial all members of the class will copy the data obtained.

9. Two soil samples must be taken for each trial. The moisture content can be obtained later.

Report: Follow the general outline as given under the instructions. Methods of adjusting can be discussed under the heading of methods when the report is written up.

TRIP NO.....

Readings.						General Data.			
Station.	Distance to Furrow. Before Test.	Distance to Furrow. After Test.	Width of Furrow.	Depth of Furrow.	Draft from Indicating Dynamometer.	Horse No.	H_1.	*L*.	Remarks.
1						1			
2						2			
3						3			
4						4			
5						5			
6						6			
7									
8						Total			
9									
10						Aver.			
11									
12						H_2			
13									
14						Time.			
15						Start.	Finish.	Req'd.	
Total........						Distance bet. sta....			
Average......						Total dis...........			

Card Number............from Recording Dynamometer.

Observers and their Stations..

....

REPORT

Test Number......

Object.......................................Date...............

Horses.			Soil.			Kind of Dynamometer....... Attachments.........
No.	Wt.	Driver.	Moisture.	Class.	Series.	

Trip No.	Furrow.						Time Re-quired.	Velocity of Plow.	H.P. Devel-oped.
	Width.	Depth.	Area of Cross Section.	Total Draft.	Draft per Sq. in. Cross Sec.	Length.			

Name.....................................

EXERCISE 5

Smoothing Harrows

Examine smoothing harrows, comparing the following: size; construction, function, and adjustment of frame, teeth, teeth fasteners, and levers.

REPORT

General Information

1. Give names of smoothing harrows.
2. Give names and addresses of manufacturers.
3. Tabulate: number of sections, width of sections, number of teeth per section, dimensions of teeth, shape of teeth, number of teeth per foot width of harrow.

Frame

4. Guarded ends have what advantages, and what disadvantages?

5. Show cross-sections of bars by sketches.

Teeth

6. How are the teeth held in place?

7. What prevents loose teeth from being lost?

8. Draw a cross-section of a tooth used in each machine examined.

9. How many edges of each tooth can be used before the tooth is worn out?

Operation

10. What provision is made for carrying the teeth off of the ground for transportation?

11. At what angle are the teeth set for smoothing? For crushing clods?

12. Draw a sketch of an evener showing how sections are attached.

13. How many levers are there? Explain the use of each.

Practical Problems

1. Give specifications for smoothing harrows to be used under the conditions stated below. Three horses are available on each farm.

> Farm A. Soil is easily worked, there are no rocks, and little work is required of a smoothing harrow.
>
> Farm B. Soil is hard to work, there are rocks, and the smoothing harrow is used a great deal.

2. (*a*) How many horses should be used on a three-section smoothing harrow 15 feet wide when harrowing freshly plowed land? Well-packed land?

(*b*) How many acres can be harrowed per day on freshly plowed land, and on well-packed land by the use of the harrow and number of horses determined upon in (*a*)?

3. In how many days can one man and four horses harrow a 20-acre field, that is freshly plowed, using a three-section harrow, each section being 6 feet wide?

EXERCISE 6

Disk Harrows

EXAMINE disk harrows, comparing the following: size; construction, function, and adjustment of frame, snubbing blocks (gauge stops), disks, bearings, bumpers, scrapers, standards, weight pans, oiling devices, levers, tongue, truck, and hitch.

REPORT

GENERAL INFORMATION

1. Give names and sizes of disk harrows.
2. Give names and addresses of the manufacturers.
3. Name kinds of disk harrows (single or double).
4. Name kinds of blades (full blade, cut-out, or spading).

FRAME

5. Why have flexible connections on a double-disk harrow?
6. For what reasons is clearance between standard and disks needed?
7. Sketch frames, showing bracing.
8. What advantages has a reversible-disk harrow?

DISKS AND BEARINGS

9. Tabulate: number of gangs; number of disks in each gang; diameter of disks; distance between disks; kind of bearings; and cross-sectional dimensions, and shape of gang bolt.
10. Describe the method of oiling the disk bearings.
11. How is the end thrust of the gang cared for?

SCRAPERS

12. Describe operation and adjustment.
13. Why are scrapers necessary?

Levers

14. How many levers are there? Explain the use of each?

15. Why are the gangs angled when in use?

16. What are the advantages of a disk harrow, the sections of which can be angled separately?

Hitch

17. Describe the methods of hitching.

18. What provision is necessary in order to use a three-horse hitch and a tongue on a disk harrow?

19. Where are the double trees attached?

Miscellaneous

20. What are the advantages and disadvantages of a cut-out disk?

21. What are the advantages and disadvantages of a tongue truck?

Operation

22. What purposes do transport trucks serve?

23. What arrangements are made to keep inner and outer disks at the same depth when the sections are angled? Explain why.

24. Describe briefly how a disk can be sharpened. Can this method be used on a cut-out disk?

25. How is land between inner disks cultivated?

26. By what arrangement can pressure be increased or decreased on the inner ends of the gangs? Why is this necessary?

27. Under what conditions can a tongue be dispensed with?

28. Describe in detail the methods of lubricating all bearings.

Practical Problems

1. Give specifications for disk harrows to be used under the conditions noted below. Four horses are available.

   Farm A. 160-acre grain and stock farm. Soil comparatively easy to work.

   Farm B. Fruit farm. Soil easily worked.

2. How must the gangs be angled when disking on side hills and when lapping the width of one gang?

3. (*a*) How many horses should be used on a 16-inch, 16-disk, single harrow when disking freshly plowed land and well-packed land?

(*b*) How many acres can be harrowed per day (not lapping) on freshly plowed land, and on well-packed land, with the harrow and team of (*a*)?

4. In what length of time can one man, with a 14-inch, 16-disk single harrow and a 4-horse team, harrow a 30-acre field if lapping the width of one gang?

5. Four horses are being used on a disk harrow equipped with a tongue. If only three horses are available, what changes are necessary on the harrow?

EXERCISE 7

Land Rollers and Pulverizers

EXAMINE land rollers, comparing the following: length; construction, function, and adjustment of frame, axle, and bearings.

REPORT

GENERAL INFORMATION

1. Give names and sizes of land rollers.
2. Give names and addresses of manufacturers.
3. Tabulate: length, number, and position of gangs.

FRAME

4. Make a sketch or sketches of frame.
5. On the double gang machine, how is a flexible frame obtained?
6. How can weight be added?

AXLES AND BEARINGS

7. Compare the diameters of the axles.
8. What kind of bearings are used?

9. Describe the method of oiling and the method of excluding dirt from the bearings.

Wheels

10. Tabulate diameter and width of wheels, and width of bearing surface of wheels on shaft.
11. Describe wheel surfaces.
12. Discuss merits of flat and corrugated rollers.

Operation

13. Under what conditions are these land rollers or pulverizers of value?
14. Explain in detail the action of the wheels on cloddy ground.
15. Describe in detail the methods of lubricating all bearings.

Practical Problems

1. Give specifications for land rollers or pulverizers to be used under the conditions noted below. Two, three, or four horses are available.

   Farm A. Land roller or pulverizer is used on wheat land and corn fields after corn is up.

   Farm B. Land roller or pulverizer is used on 200 acres of land planted to wheat.

2. How many acres per day can be rolled with a 10-foot land roller and three horses?
3. How long will it take to roll 40 acres with a 10-foot roller and four horses?

EXERCISE 8

Grain Drills

Examine grain drills, comparing the following: size; style; construction, function, and adjustment of frame, wheels, levers, seat, footboard, hopper, agitator, feeding device, seed shaft, seed tubes, furrow openers, drag bars, scrapers, bearings, covering device, land measure, and hitch.

REPORT

General Information

1. Give names and sizes of grain drills.
2. Give names and addresses of manufacturers.

Frame

3. Draw a plan and a cross-section of the main frame, paying particular attention to all braces.

Wheels and Axle

4. Where are the wheels located on the " low down " type?
5. Compare the advantages and disadvantages of continuous and divided axles on the high-wheel style.
6. Which machine has roller bearings on the main axle? Plain bearings? Self-aligning bearings?
7. Compare machines as to width of tire and height of wheels.
8. On which drill will the mechanism continue in action even if one wheel stops for a moment?

Hopper

9. Describe grass seed and fertilizer attachments.
10. Explain the use of truss rods.
11. What provision is made for delivering all the seed in the hopper to the seed cups when the hopper is nearly empty?
12. Of what advantage is it to have the hopper lid automatically held open or shut?

Seed Cups

13. Name kinds of seed cups used and describe them.
14. Give advantages and disadvantages of each kind.
15. How is power transmitted from the main shaft (axle) to the feed shaft?
16. How many revolutions does the feed shaft make to one of the drive wheel? How can this be varied?
17. Where can the seed cups be adjusted for wear?

18. How are seed cups made adaptable for different kinds of grain?

19. What provision is made for regulating the amount of grain sown?

20. If too much or too little grain is sown out of one feed cup, how can the proper adjustment be made?

Seed Tubes

21. Describe seed tubes.

22. How can seed tubes be replaced if damaged?

Furrow Openers

23. Tabulate: number, distance apart, kind and size of furrow openers, and kind of boot.

24. How are the furrow openers held in the ground?

25. Why is the front end of the frame bent down or the drag bars attached to a rod some distance underneath the front rail?

26. What provision is made for planting seed at a uniform depth when the grain drill is passing over an uneven surface?

27. If the boot is adjustable, explain how the adjustment can be made and give the conditions in which this may be advisable.

28. State advantages and disadvantages of closed and open delivery.

29. How are the bearings protected from the dirt?

Levers

30. How many levers are there? Explain the use of each.

31. What provision is made for assisting the operator to raise the furrow openers? To put the furrow openers deeper into the ground?

Covering Device

32. Describe the covering device, including method of attachment.

33. When is it needed?

Operation

34. How is the machine thrown into gear?

35. What effect has the use of the press wheel attachment on ease in backing up?

36. How can seed cups be emptied when you are through drilling?

37. How many horses are needed?

38. Under what conditions is it desirable to throw one-half of the machinery out of gear? How is this accomplished?

39. How many corn rows will the grain drill cover?

40. Set the land measure to read six acres and describe the operation.

41. Describe in detail the methods of lubricating all bearings.

Practical Problems

1. Give specifications for grain drills to be used under the conditions noted below. Either two or three horses are available.

Farm A. Land level, without rocks, located in the semi-arid districts where fall seeding is practiced.

Farm B. Land level, without rocks, located in the region where the drilling is done mostly in the spring, frequently on fields covered with slush or mud.

Farm C. Rocky and hilly soil, but with little trash.

2. How many horses should be used on a 12 by 7 drill?

3. In what length of time can one man drill a 160-acre field with four horses and a 14 by 7 drill?

4. If the ground has been prepared for wheat with a lister, what is the remedy if there is too much whipping of the grain drill tongue?

EXERCISE 9

Grain Drill Calibration

Test: Obtain seed from tool room and make two tests with **each** seed, sowing different amounts each time. After putting

the grain in the hopper, place receptacles underneath each of the spouts to catch the grain. With the machine in gear turn the wheel through one hundred revolutions. Weigh the seed collected. Determine by calculation the amount that should have been drilled.

Report: Follow the general outline as given under the instructions.

SAMPLE DATA SHEET

TEST NO.....

Name of Drill.................... Kind of Seed...................

Weight per bushel..............

Weight of seed from each spout.

Rate per Acre.	1	2	3	4	5	6	7	8	9	10	11	12

Rate per Acre.	Calculated Amount per 100 Revolutions.	Total Amount Obtained.	Per cent Inaccurate.

NOTE.—When the test is completed return the instruments, place the grain in the hopper, and clean up around the machine.

EXERCISE 10

Corn Planters

EXAMINE corn planters, comparing the following: style; construction, function, and adjustment of front frame, rear frame, seat, wheels, reel, marker, power transmission, clutch, seedbox, check head, variable drop device, levers, furrow openers, and valves.

REPORT

General Information

1. Give names of corn planters.
2. Give names and addresses of manufacturers.

Frame

3. How can width of row be varied?
4. What provision is made for keeping the frame level if one side runs deeper than the other?

Wheels

5. Describe wheels used, giving advantages of each type.
6. Give sizes and width of wheels.

Seed-box

7. How can the hoppers be emptied?
8. How can the plates be changed without emptying the hoppers?
9. Which planter has intermittent plate movement when checking? Continuous plate movement?
10. Explain how seed plates and valves operate when checking.
11. On which planter are plates arranged for hill drop? Edge drop? Flat drop?
12. How is the number of kernels in each hill determined?
13. What advantages has the sight feed?
14. What is a variable-drop corn planter?
15. Describe movement of plates when checking.
16. Describe movement of plates when drilling.
17. What adjustments are necessary before the planter will drill?
18. What provision is made for assisting corn to seed plates?
19. Describe cut-off and knock-out, giving reasons for their use.
20. What purpose is served by a groove in the seed ring?

Furrow Openers

21. Describe furrow openers, giving conditions to which each type is adapted.

22. What purpose do the valves serve? Give their location.

23. In what manner can the disk furrow openers be attached to the runner furrow openers?

Levers

24. How many levers are there? Explain the use of each.

25. Why is it advantageous to be able to change the rate of drop while the team is in motion?

Checking Attachment

26. How is the reel attached?

27. From what source is the power for winding the reel derived?

Operation

28. What effect on accurate checking has a short neck-yoke strap?

29. Under what conditions should the frame be floated?

30. Describe the method of laying out the wire and the method of reeling up the wire.

31. Describe in detail the methods of lubricating all bearings.

Practical Problems

1. Give specifications for corn planters to be used under the conditions noted below:

    Farm A. Corn checked in fields $\frac{1}{4}$ mile long. Very little trash on the ground.

    Farm B. Corn drilled. There is usually a little trash on the ground.

2. With a two-row planter, how many acres can be planted by one man in a day if the rows are 3 feet 6 inches apart?

3. How long will it take to check a 40-acre field, under conditions the same as in Prob. 2?

4. A planter is properly adjusted, but at noon the operator changes teams. The second team is much smaller than the first. What adjustments are necessary?

5. After planting for an hour the operator finds that no corn is being planted through one of the furrow openers. Where should the operator look for the trouble?

6. Edge drop plates have been selected for a certain variety of corn. A second variety whose kernels are the same in size as the first variety, only much wider, must be used in one of the fields. What adjustments are necessary before the second variety can be planted?

EXERCISE 11

Corn Planter Calibration

THE object of this exercise is to study the effect of proper plate selection on the accuracy of drop.

After securing assignment to machines, obtain corn from the tool room. On the machine assigned select that plate which seems best suited for the seed at hand and two other plates—one the holes of which are smaller, and one the holes of which are next larger than the holes in the plate first selected. Label the first plate " Right," the one with the smaller holes " Small," and the one with the larger holes " Large."

With the machine set to drop three kernels per hill run a test of 200 hills with each plate, recording the number of 0, 1, 2, 3, 4, and 5 kernels per hill. While making the test be sure to see that the planter parts move at the same speed as if the machine were passing over the ground at the rate of $2\frac{1}{2}$ miles per hour.

Preliminary data should be recorded on cross-ruled paper, four squares to the inch, each square representing one hill. A block of squares can be ruled off containing 200 squares. Repeat the operation for other planters assigned.

Report: Follow the general outline as given under the instructions. The final data sheet should be similar to the one below.

SAMPLE DATA SHEET

Name of Planter....................

Method of Selecting Corn............

Kind of Drop.....................

Plate. Number of Hills Containing 0 to 5 Kernels.

Designation.	No.	0	1	2	3	4	5	Per cent of Accuracy
"Small"	.....	.....	.....	.....	.....	.....	.....	....
"Right"	.....	.....	.....	.....	.....	.....	.....	....
"Large"	.....	.....	.....	.....	.....	.....	.....	....

Note.—When the test is completed, return the instruments to the tool room, place the grain in storage, and clean up around the machines.

EXERCISE 12

Listers

Examine single-row listers and double-row listers, comparing the following: type; construction, function, and adjustment of frame, wheels, tongue, levers, bottom, root cutter, planting attachment, subsoiler, and covering device.

REPORT

General Information

1. Give names and sizes of listers.
2. Give names and addresses of manufacturers.

Frame

3. Which machine has a frame?

4. How can the width of row be changed on the one-row machine? On the two-row machine?

5. What are the advantages of the adjustment for changing width of row?

6. What effect has the length of the lister on the ease with which the bottom comes out of the ground, and on the ease with which the machine can be turned around?

Wheels

7. How can the lister be held in its proper place on side hills?

8. What is likely to happen if the machine is backed up when the bottom is in the ground?

9. Explain adjustment necessary when the lister runs to one side.

10. What advantages has the wide-tread lister?

Levers

11. How many levers are there? Explain the use of each.

Bottom

12. Why have flexible beams? Rigid beams?

13. Why is it necessary to have the lister enter the soil point first?

14. How can the suction be changed?

15. What is the difference in construction between a plow bottom and a lister bottom?

16. Why have shields above the moldboards?

17. What purposes does the root cutter serve?

Planting Attachment

18. How is throwing out of gear accomplished when the lister bottom is raised?

19. How are the gears and chains protected from dirt and trash?

20. Describe the method of driving the planter mechanism.

21. How is the variable drop feature obtained?

22. How is the distance apart of kernels regulated?

23. Compare the seed hopper and plates with those used on corn planters.

24. What is the subsoiler? Give purpose and adjustments.

25. Which subsoiler and seed spout will plant the kernels in loose ground? On hard ground?

26. Compare listers as to ease of attaching and detaching planting device.

27. Give advantages of the floating drill.

Covering Device

28. Describe the method of covering the kernels of corn. Why should the coverers be adjustable?

29. What is the object of having the center of the disk coverers open?

Hitch

30. What is the result when the hitch is too low? Too high?

Operation

31. What means are provided for regulating the distance between the rows?

32. How can the ordinary lister be made into a loose-ground lister?

33. Under what circumstances should the operator get off the machine when it is turning at the ends of the rows?

34. How must the tongue be set for three horses? Four horses?

35. How can the lister be made into a middle buster?

36. Describe in detail the methods of lubricating all bearings.

Practical Problems

1. Give specifications for listers to be used under the conditions noted below. Either two or four horses are available.

   Farm A Sixty acres of slightly rolling land is listed each year.

   Farm B. Twelve acres of level land, in which are many stumps, is listed each year.

2. With a one-row riding lister and four horses, how many acres can a man list in one day if the rows are 3 feet 6 inches apart?

3. When busting out ridges with a wide tread lister why should the hitch be lower than when listing?

4. If planting with a lister in listed ground should the kernels be planted in the old row or between the rows?

EXERCISE 13

Cultivators

EXAMINE walking, single-row riding and double-row riding cultivators, comparing the following: size; style; hitch; construction, function, and adjustment of frame, couplings, gangs, shields, shovels, levers, springs, seat, spread arch, and expanding axle.

REPORT

GENERAL INFORMATION

1. Give names of cultivators.
2. Give names and addresses of manufacturers.
3. Tabulate: number of rows, and whether riding, walking, or combined, and number of horses used.

FRAME

4. Describe method of balancing.
5. Why have a balanced frame?
6. What part limits the size of corn that can be cultivated?
7. Give maximum and minimum height of hitch for each cultivator.
8. How can the frame be narrowed for use in cultivating such crops as potatoes?

WHEELS

9. How can the distance between the wheels be changed?
10. Tabulate: height of wheels and width of rims, and show by sketches sections of tires.
11. Why give pitch to the wheels?

GANGS

12. How is the distance between the gangs changed at the coupling? When is it necessary?
13. If the couplings are flexible, what provision is made for taking care of lost motion and wear?
14. What arrangement is made to make easier the lifting of the gangs or the forcing of the gangs into the ground?

15. On which cultivators will the gangs remain level when shifted horizontally from the mid-position?

16. What kinds of shields are used and how are they adjusted?

SHOVELS

17. What purpose is served by the spring trip and the pin break features?

18. Why use straight, twisted, crowned, flat, and spear-point shovels?

19. How are shovels attached and adjusted?

LEVERS

20. How many levers are there? Explain the use of each.

OPERATION

21. Describe the method of dodging hills of corn.

22. How are the cultivators guided?

23. Describe in detail the methods of lubricating all bearings.

Practical Problems

1. Give specifications for cultivators to be used under the conditions stated below. From two to five horses are available.

Farm A. One hundred acres of land, level and easily worked, is planted to corn each year with a two-row corn planter.

Farm B. Forty acres of rolling land, thickly strewn with rocks, is planted to corn.

Farm C. Ten acres of land, hilly and full of stumps is planted to corn.

2. With a one-row riding cultivator and two horses, how many acres can a man cultivate in a day, if the rows are 3 feet 6 inches apart?

3. How can the cultivator shovels be adjusted to make it easy to hold the gangs in place under the following con-

ditions: cultivator with flexible couplings, six twisted shovels, and no spread arch or jockey?

4. How does the length of the beams having flexible couplings affect the ease with which gangs can be moved in and out in dodging corn?

EXERCISE 14

Cultivator Assembling

TAKE apart, assemble, and report as follows:

Taking Down: Remove parts in the following order: Shields, tool box, seat, single-trees, neck-yoke, evener, shovels, levers, handles, beams, wheels, tongue, and parts necessary to prepare for shipment.

Assembling: Consult the instructor before and after assembling. Put cultivator together in reverse order from that used in taking apart. Adjust the machine properly.

Report: Follow the general outline as given under instructions. Be sure to include name of cultivator, name and address of manufacturer, and state time required for taking down and assembling.

EXERCISE 15

Lister Cultivators

EXAMINE single-row and double-row lister cultivators, comparing the following: construction, function, and adjustment of frame, wheels, levers, cultivating parts, tongue, and hitch.

REPORT

GENERAL INFORMATION

1. Give names and sizes of lister cultivators.
2. Give names and addresses of manufacturers.

TILLAGE PARTS

3. Describe the tillage parts.
4. How can the tillage parts be adjusted to throw toward

or away from the corn? Are the adjustments hard or easy to make?

5. What provision is made to keep dirt out of the bearings?

Seat Attachment

6. How is the seat on the two-row machine kept half way between the cultivated rows? Is this important? If so, explain why.

7. In what manner is the seat bar strengthened?

Levers

8. How many levers are there? Explain the use of each.

9. Why is the machine so constructed that the shovels can be raised without raising the disks?

Wheels and Guides

10. What purposes are served by the outrigger wheels on the single-row riding lister cultivator?

11. Describe guides (furrow wheels) and give reasons for their use.

12. Give advantages and disadvantages of operating lister cultivator with furrow wheels set with front gather.

Operation

13. Why hitch to the tillage parts?

14. What are the disadvantages of hitching too low?

15. Explain how to set the tillage parts for going over the corn the first time. The second time.

16. Describe in detail the methods of lubricating all bearings.

17. Why run shovels deep and wide apart the first time over.

18. On the two-row lister cultivator set one gang for the first cultivation and the other for the second cultivation. Call the instructor to pass on your work.

Practical Problems

1. Give specifications for lister cultivators to be used under the conditions stated below:

Farm A. Sixty acres of listed corn, the rows evenly spaced.

Farm B. Twenty acres of listed corn, the rows not so evenly spaced.

2. How many acres can one man with a two-row lister cultivator and four horses cultivate in a day?

3. If man labor is worth 20 cents an hour and horse labor 10 cents an hour, how much more expensive per acre is method (*b*) than method (*a*)?

(*a*) Two-row lister cultivator.

(*b*) One-row lister cultivator.

EXERCISE 16

Grain Binders

Examine grain binders, comparing the following: width of cut; construction, function, and adjustment of frame, wheels, chains, shafts, gears, reel, cutter bar, sickle, pitman, elevators, binder attachment, bundle carrier, transport trucks, tongue truck, and levers.

REPORT

General Information

1. Give names and sizes of grain binders.
2. Give names and addresses of manufacturers.

Frame

3. Compare the binders as to material of which frame is made and as to strength.

Wheels

4. What effect has the width of tire and the height of main wheel on the use of binders in soft fields?

5. Tabulate: diameter and width, kind of bearings, and method of oiling of main wheel and grain wheel.

Shafting and Gears

6. Draw sketches showing transmission of power from the main wheel to the reel, pitman, and binder attachment. Designate the position of the clutch.

7. How are the main drive chains kept at the proper tension?

8. Why use self-aligning bearings on the countershaft?

9. Where are plain, roller, and ball bearings used on the countershaft, and main wheel axle? Why are they used at these points?

10. Describe the adjustment on countershaft for taking up the wear in bevel gears.

Pitman

11. How is it removed if broken?

12. What parts of a pitman are adjustable for wear?

Sickle

13. How is the pitman connected to the sickle?

14. Why use smooth sections? Serrated sections?

Cutter Bar

15. How does the cutter bar differ from those on mowers?

16. When cutting properly where is the center of the section in relation to the guard at the extreme throw of the crank? Explain.

Reel

17. Tabulate: number of reel slats, number of spiders, and method of support at outer end.

18. How can the position of the reel be changed? Why is this necessary?

19. How does the velocity of the travel of the reel slats compare with the velocity of the team?

Elevators

20. Draw cross-section sketch of elevators, showing travel of grain, rollers, canvases, and direction of motion of canvases.

21. What effect on the draft has the height to which grain is elevated above the platform?

22. Why have devices for loosening the canvases without unbuckling the straps?

23. Discuss merits of materials from which the canvas straps are made.

24. How are the canvases driven to make the tight side of the canvas always next to the grain?

25. What provision is made to permit heavier or larger bunches of grain than usual to start up the elevator?

26. What purpose do the deck rollers serve?

Binder Attachment

27. The numbers of packers, proximity of the packers to the lower elevator canvas and the slope of the deck, have what effects on the operation of the machine?

28. Discuss advantages and disadvantages of the two and three-packer construction.

29. Describe the twine tension. Why necessary?

30. How is the twine pulled from the knotter bills in tying the knot?

31. By what means are the bundles cast onto the bundle carriers?

32. What provision is made to prevent wear in the eye of the needle?

33. Describe the butt adjuster and give reasons for using it.

Bundle Carrier

34. What is the action of the bundle carrier when dumping?

35. Why have the carrier raised from the stubble before swinging into position?

36. How is the carrier affected when it hits an obstruction?

Levers

37. How many levers are there? Explain the use of each.

Operation

38. How is the entire machine raised and lowered? Why necessary?

39. Explain how to test out the various parts of a new binder before starting to cut to be sure that everything is right.

40. Explain in detail how the size and the tightness of the bundles are regulated.

41. Describe in detail the methods of lubricating all bearings.

Practical Problems

1. Give specifications for binders to be used under the conditions stated below. Three or four horses are available.

   Farm A. Two level grain fields of 40 acres each with no rocks or stumps.

   Farm B. Four grain fields of 10 acres each on rolling land.

2. With a 7-foot grain binder and four horses, how many acres can a man cut in a day?

3. How many days will it take for one man to cut 80 acres of wheat with a 7-foot binder and four horses?

4. The cutting conditions are such that the straw is winding around the deck roller. How can the trouble be remedied?

5. Elevator canvases creep and broken slats on canvases are a frequent occurrence. Explain how to overcome these difficulties.

6. In heavy tangled grain it is sometimes noticed that the whole machine is stopped by choking down due to the fact that the binder attachment cannot discharge the bundle. What is the remedy?

7. A binder with a tongue truck does not cut a full swath. What adjustment is necessary?

EXERCISE 17

Binder Attachment Adjustment

BEFORE making any adjustments test the binder attachment to see that it is properly adjusted.

When at rest the point of the needle should project a little above the deck. When the needle comes over the disk there should be $\frac{1}{4}$ inch between the disk and the needle.

"Binder trip should be set so that pulling on a straight line with discharge arms at trip hook it will trip at 22 pounds. Tension on twine pulling through eyes of needle when properly threaded should be from 6 to 8 pounds, pulling on a straight line with the deck. Cord holder spring should be set so the twine pulls out of disk at 35 to 40 pounds; be sure to pull straight up, but before pulling run the binder around twice and take out band tied by hand to be sure the twine is in the disk properly." * The knife should cut the twine just a little before the discharge arms touch the bundle.

With the binder attachment properly threaded, go through the necessary movements to tie a bundle. Observe closely the function of all the parts, and the characteristics of the knot.†

TWINE STRIPPER

1. Note carefully the action of the twine stripper.

NEEDLE PITMAN

2. Lengthen the needle pitman gradually, noting the effect on the knot.
3. Draw a sketch of the band which you finally obtain.
4. Why and under what circumstances does this condition exist?
5. What happens when the needle eye becomes badly worn?
6. Shorten the needle pitman and see what trouble you find.
7. Leave the needle pitman properly adjusted.

* John Deere Plow Co., Harvester Works, Moline, Ill.

† When tying these knots, keep about a 30-pound pull on the disk strand of the loop in which the bundle should lie.

Knotter Bills

8. Gradually loosen the tension on the knotter bills and note the effect on the knot.

9. Draw a sketch of the knot obtained when the bills are too loose.

10. Why, and under what circumstances, does this condition exist?

11. What is the function of the " hump " on the upper bill?

12. Decrease the tension gradually and note what happens.

13. If the spring is too tight, what is most likely to happen when the bundle is cast? Why?

14. Leave the tension properly adjusted.

Cord Holder Spring

15. Gradually loosen the cord holder spring, and note the effect upon tying.

16. Draw a sketch of the band obtained.

17. Why and under what circumstances does this condition exist?

18. Gradually tighten the cord holder spring and note the effect on tying.

19. With the spring very tight, perform the following: (*a*) with the needle advanced as far as possible, and while both ends of the band are still in the disk, exert about a 50-pound pull on the loop. If the loop pulls out, note the condition of the ends of the twine; and (*b*) with the needle in its position of rest, exert a 20-pound pull on the twine in the disk. What is likely to occur when the strain on the twine increases as the needle advances and the operation of tying the knot begins?

20. Leave the cord holder spring properly adjusted.

Disk Parts *

21. If possible, throw the disk parts out of time and note the effect.

22. Why must the disk be timed?

* Do not perform this part of the exercise unless so directed by the instructor.

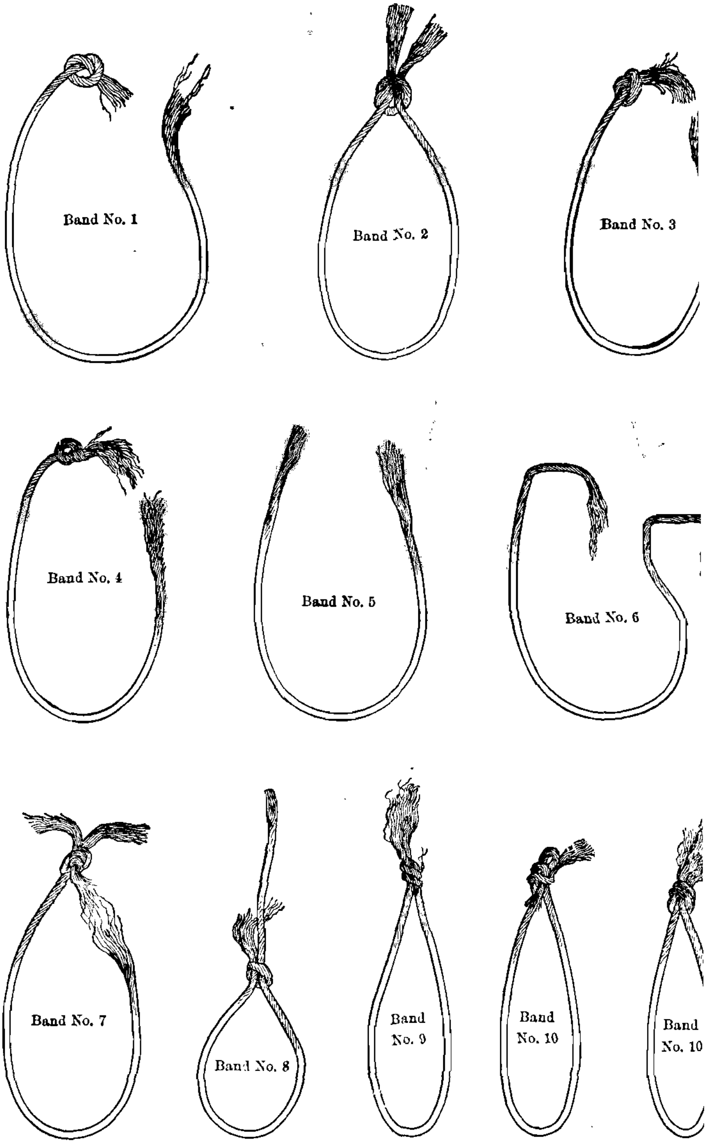


PLATE II.—Binder Knots.

Practical Problems

1. Give remedies for bands 1–9 inclusive.

2. Give causes of and remedies for the following: (*a*) Discharge arms fail to revolve completely or fail to start; (*b*) Discharge arms revolve continually; and (*c*) Discharge arms not set tight.

3. In a field of grain easily handled by the binder, it is noticed that the bundles are not being tied regularly. In testing the binder head attachment it is found that the twine tension, the cord holder spring, and the trip spring are properly adjusted. The needle, needle pitman, discharge arms, dogs and dog driver are working properly. Where would you look for the source or sources of trouble?

EXERCISE 18

Binder Attachment Assembling

TAKE apart, assemble, and report as follows:

Taking Down: Remove parts in the following order: (1) Needle pitman, (2) Main sprocket or gear wheel, (3) Needle, (4) Packers, (5) Clutch ratchet, (6) Clutch dog disk, (7) Cord holder spring, (8) Knotter bill spring, (9) Knotter hook, (10) Stripper and knife, (11) Twine disk.

NOTE.—Under ordinary conditions keys should be driven in tight, but since the attachment is to be taken down many times it will not be necessary to drive the keys home.

Assembling: Consult the instructor before and after assembling.

Reassemble the binder attachment in the reverse order from that used in taking down. Adjust properly.

Report: Follow the general outline as given under the instructions. Include name of the binder to which this attachment belongs, name and address of the manufacturer, and the time required for taking down and assembling.

EXERCISE 19

Practice in the Making of Repair Lists

Directions: After receiving an assignment to a binder head attachment, obtain tool kit, binder twine and repair catalogue from tool room. After examining attachment closely, try to tie a bundle. Then order repairs that you think are necessary. Write out order and present it at the tool room. Place repairs on the binder head attachment and again try to tie a bundle. When satisfied with the knot obtained, call instructor to pass on your work.

Report: Follow the general outline as given under the instructions. Be sure to explain all steps in detail.

EXERCISE 20

Placing Gas Engine on Binder

Directions: After being assigned to a binder and a gas engine, obtain a tool kit and a copy of the manufacturer's instructions from the tool room.

Follow these instructions in placing the engine on the binder. Test the outfit by starting engine after it is attached to the binder.

Find the speed of binder crank shaft when the engine is running at normal speed, and the r.p.m. of engine when the binder crank shaft is making 225 r.p.m.

Call the instructor to pass on your work.

Report: Follow the general outline as given under the instructions.

EXERCISE 21

Corn Binders

Examine corn binders, comparing the following: construction, function, and adjustment of frame, wheels, gearing, shafting, gatherers, pitman, sickle, knives, binding attachment, bundle carrier, levers, tongue truck, and bundle elevator.

REPORT

General Information

1. Give names of corn binders.
2. Give names and addresses of the manufacturers.

Wheels

3. Tabulate: diameter, width of tire, kind of bearings, and method of oiling of the main wheel and of the grain wheel.

Shafting and Gearing

4. Draw a sketch (or sketches) for each corn binder, showing transmission of power from main wheel to elevator chains, to sickle, and to binder attachment. Designate the position of the clutch.
5. How is the main drive chain kept at the proper tension?
6. What provision is made for preventing corn leaves, weeds, etc., from winding around the shafts?
7. Why use self-aligning bearings on the countershafts and on the crankshaft?
8. Where are plain, roller and ball bearings used on the countershafts, crank shafts, and main wheel axle?

Pitman

9. What parts of a pitman are adjustable for wear?
10. If a pitman is broken, how can it be removed?

Sickles and Knives

11. Describe the cutting devices. Measure length of sickle and of knives.
12. Why is it necessary to have knives in addition to a sickle?
13. How are the knives adjusted?

Elevators

14. What purpose do the gathering boards serve?
15. Describe the method of carrying stalks to the binder head attachment.
16. Compare machines as to number, construction, and adjustment, of conveyer chains.

Binder Attachment

17. Describe twine tension. Why is it necessary?

18. How is the twine pulled from the knotter in tying the knot?

19. By what means is the bundle discharged onto the bundle carrier?

20. What provision is made to prevent wear in the eye of the needle?

21. How is the location of the twine band changed for binding tall or short corn?

22. How does this attachment differ from the one on the binder studied in Exercise 16?

23. Thread the machine and then tell how it was done.

Bundle Carrier

24. What attachment can be used for loading bundles on wagons or racks?

25. Compare this bundle carrier with the one used on the grain binder.

Levers

26. How many levers are there? Explain the use of each.

Operation

27. Describe in detail the methods of lubricating all bearings.

28. Draw a sketch of the evener showing the number of horses used.

29. Why use a tongue truck?

30. Describe the quick turn feature of the tongue truck.

31. How often must side knives be removed and sharpened when cutting very tough corn?

Practical Problems

1. Give specifications for corn binders to be used under the conditions stated below.

Farm A. Sixty acres of corn planted yearly on level land.

2. With a corn binder and three horses, how many acres can a man cut in a day if the corn yield is 45 bushels per acre?

3. With a corn binder and three horses how long will it take to cut 40 acres of corn yielding 45 bushels per acre?

4. Compare the cost of harvesting corn with a binder or with a sled harvester, in a field yielding 50 bushels per acre.

The binder is pulled by three horses. The sled harvester is pulled by one horse and operated by two men.

EXERCISE 22

Mowers

EXAMINE mowers, comparing the following: width of cut; width of tread; construction, function, and adjustment of frame, push bar, yoke, wheels, levers, gearing, bearings, pitman, draft rod, drag bar, cutter bar, and sickle.

REPORT

General Information

1. Give names and sizes of mowers.
2. Give names and addresses of manufacturers.

Frame

3. Draw a sketch of the frame, designating push bar, drag bar, yoke, and location of the countershaft and the crank shaft.

Wheels

4. Tabulate: diameter (excluding lugs) of wheels, width of tires, number of pawls, and location of ratchets.
5. How can worn out pawls and ratchets be renewed?

Gearing

6. Draw a sketch showing transmission of power from drive wheel to pitman.
7. What provision is made to protect the gears from dirt?
8. How is the machine thrown out of gear?

Levers

9. What is a vertical lift mower?

10. How many levers are there? Explain the use of each.

11. How high can the cutter bar be raised to pass over obstructions and still have the sickle in operation?

Pitman

12. How can bushings be replaced at the crank end?

13. If broken, how is the pitman removed and replaced?

14. What adjustments for wear at each end?

15. What effect has the length of the pitman upon sickle and cutter bar wear?

Cutter Bar

16. Describe the method of carrying the cutter bar when on the road.

17. When in a vertical position which cutter bar is straight and which is curved ? Why?

18. What provision is made for carrying a portion of the weight of the cutter bar on the frame? How does this affect the traction?

19. Find swath board, guards, ledger plates, clips, and wearing plates. Give the purpose of each.

20. How can the cutter bar be aligned with the pitman?

Sickle

21. Describe the method of timing the sickle.

22. How is the pitman connected to sickle?

23. How many strokes will the sickle make while the mower advances one foot?

24. Remove the sickle from the cutter bar. After the instructor has inspected your work replace the sickle.

Bearings

25. By what means can the end thrust of the crank shaft at the pinion end be taken care of?

26. Why are roller bearings not used at the crank end of the crank shaft?

Operation

27. Describe the draft rod. How does it work?

28. How far will the mower travel before the sickle moves?

29. What provision is made for relieving side draft?

30. To what four parts of the sickle and cutter bar would you look for trouble if the grass is "chewed" off instead of being cut evenly?

31. By what means can the height of the stubble be regulated?

32. How frequently should the pitman box be oiled?

33. Describe in detail the methods of lubricating all bearings.

Practical Problems

1. Give specifications for mowers to be used under the conditions stated below:

Farm A. One hundred acres of level land in alfalfa.

Farm B. Forty acres of rolling land in timothy and clover.

Farm C. Thirty acres of rolling land, with many stumps trees, and rocks, planted to timothy.

2. How many acres can a man cut in one day with each of the following: a 5-foot; a 6-foot; and a 7-foot mower?

3. (*a*) How long will it take one man to cut 30 acres with a 7-foot mower? (*b*) Same as (*a*) but with a 5-foot mower?

4. A farmer insists that his mower has too much neck weight. Upon observing the mower at work, the company expert notices that the tongue pulls down very little on the neckyoke. What caused the farmer to believe there was too much neck weight?

5. What are the causes of: (*a*) heavy draft? (*b*) uneven stubble and side draft? (*c*) broken knives? (*d*) undue wear on outside clips and center wearing plates? (*e*) cutter bar clogging at one point? (*f*) cutter bar parts gumming up badly?

8. How is damage to teeth prevented when an obstruction is hit?

9. Why must the teeth be kept in almost a vertical position as the reel revolves?

10. What provision is made for changing the pitch of the teeth?

11. What is the ratio of r.p.m. of the drive wheel to r.p.m. of rake cylinder?

Operation

12. How is the machine thrown out of gear?

13. What effect will throwing in gear have on the parts concerned if the machine is in motion?

14. What adjustments are necessary to change the side delivery rake into a tedder?

15. Draw a sketch of a hay field, showing: swaths cut by the mower, direction of the side delivery rake, and windrows raked by this machine.

16. Describe in detail the methods of lubricating all bearings.

Practical Problems

1. Give specifications for side delivery rakes to be used under the conditions stated below. Two horses and hay loaders are available.

   Farm A. One hundred acres of alfalfa on level land. The hay is to be placed in hay sheds.

   Farm B. Eighty acres of timothy and clover on rolling land. The hay is to be put in the barn.

2. How many acres can a man rake in a day with an 8-foot side-delivery rake?

3. How long will it take to rake 100 acres of alfalfa with an 8-foot side-delivery rake?

4. How should the pitch of the teeth be changed when passing from a field of light hay to a field of heavy hay?

5. Why is alfalfa hay worth more when a side-delivery rake instead of a sulky rake is used in putting up the crop?

6. Under what conditions should a sulky rake be purchased? A side-delivery rake?

EXERCISE 25

Hay Loaders

Examine rake type of hay loaders and cylinder type of hay loaders, *comparing the following:* width; height of delivery; hitch; construction, function, and adjustment of frame, wheels, cylinder, rake teeth, and elevator.

REPORT

General Information

1. Give names and sizes of hay loaders.
2. Give names and addresses of manufacturers.

Elevator

3. What is the method of elevating hay?
4. How is tension on elevator chains adjusted?
5. What means are used to prevent the hay from being blown off the elevator on windy days?
6. Measure the minimum and maximum heights to which the hay can be delivered?

If Cylinder

7. Describe cylinder and method of driving.
8. Discuss merits of single-cylinder and of double-cylinder types.
9. How is hay prevented from following the cylinder around?
10. What is the action of the cylinder on uneven ground?

If Rake

11. Describe methods of operating the rakes.
12. How many feet of ground are passed over per stroke of each group of bars?

Miscellaneous

13. Compare the advantages and disadvantages of cylinder and rake types of hay loaders.

Operation

14. Describe in detail the methods of lubricating all bearings.

15. What occurs when the load is so high that the hay backs up against the top of the elevator?

16. Which of these machines can be used for loading hay from the swath? windrow? cock? or from two or all three of these places?

17. Describe the method of attaching the loader to the wagon.

Practical Problems

1. Give the specifications for hay loaders to be used under the conditions stated below:

Farm A. Eighty acres of alfalfa raked with a side-delivery rake.

Farm B. Sixty acres of alfalfa and no rake available.

Farm C. Fifty acres of timothy and clover raked with a side-delivery rake.

2. How many acres of hay in one day can be hauled from the windrow to the barn if two men and two horses do the work and the hay is unloaded by hand?

3. Same as 2, but with three men and two horses.

4. Same as 2, but with two men and two horses, unloading by fork.

5. Same as 4, but with three men and two horses.

EXERCISE 26

Pumps

Examine pumps, comparing the following: construction, function, and adjustment of standard, top, spout, air chamber, stuffing box tube, and handle.

REPORT

General Information

1. Give laboratory numbers.
2. Give names and addresses of manufacturers.

Standard and Top

3. State which are lift pumps. Force pumps. What is the difference between a force pump and a lift pump?

4. Describe the pump standard.

5. Of what advantage is it to be able to turn the pump top in any direction?

6. What is the difference between a hand and a windmill top?

7. What advantages has an adjustable pump base?

8. What is necessary to adapt a windmill top pump to a power drive?

Spout and Outlets

9. How is the spout attached to the standard?

10. Describe the spout, giving reason for this particular shape.

11. What provision is made for attaching a hose to the spout?

12. What is a three-way pump?

13. What provision is made for delivering water at a point other than at the spout? Explain its use.

Air Chamber

14. Describe the air chamber. What purpose does it serve?

15. What is the purpose of the screw plug?

Stuffing Box

16. Explain the difference between a stuffing box and a stuffing-box tube.

17. Under what conditions are stuffing boxes and stuffing-box tubes used?

Handle

18. How is the handle connected to the pump rod?

19. What is the advantage of the adjustable stroke?

20. How does the leverage affect the force necessary to raise water and the amount raised?

Miscellaneous

21. Why should there be a hole in the pipe above the cylinder?

22. What is the purpose of a sand point in the well?

Practical Problems

1. Give the specifications for pumps and cylinders to be used under the conditions stated below:

    Farm A. A windmill supplies power to a pump that must raise the water 80 feet. The water must be delivered at the pump and also to a water tank 200 feet from the well.

    Farm B. The water from a well 25 feet deep must be delivered to a tank 40 feet above the ground, and at the spout. A gas engine supplies the power.

2. How far must the cylinder be from the surface of the ground if the distance to water is 75 feet?

EXERCISE 27

Pump Cylinders

Examine cylinders, comparing the following: construction, function, and adjustment of valves, valve seats, cylinder, and caps.

REPORT

General Information

1. Give the laboratory numbers and dimensions of cylinders.
2. Give names and addresses of manufacturers.

Cylinders

3. Give advantages and disadvantages of iron, brass, and brass-lined cylinders.
4. Which cylinders have projecting caps? Flush caps?
5. Under what conditions should cylinders with flush caps be used?

Piston

6. Compare pistons as to number of leathers used.

7. Describe the valves in pistons. (Three-pronged poppet, single-pronged poppet, hinge, or ball valve.)

8. Of what materials are the piston valves and valve seats made?

9. Describe the valve at the lower end of the cylinder.

10. Of what materials are the lower valves and valve seats made?

11. What different constructions are employed in the lower valves and seats?

Miscellaneous

12. Compare the materials in cylinder valves, and valve seats as to durability.

EXERCISE 28

Pump Test

The object of this test is to determine the efficiency of the pump assigned.

Method: Make the test, weighing the water obtained in forty strokes. (One gallon of water weighs $8\frac{1}{3}$ pounds. One gallon equals 231 cubic inches.)

Sample Data Sheet

1. Laboratory number of pump.
2. Kind of cylinder.
3. Numbers of leathers in piston.
4. Kinds of valves in piston.
5. Kinds of valves at lower end of cylinder.
6. Length of cylinder.
7. (*a*) Length of stroke.
   (*b*) Diameter of cylinder.
8. Volume of one stroke in cubic inches.
9. Volume of forty strokes in cubic inches.
10. Calculate number of gallons in forty strokes.

11. Gallons obtained by test.
12. Loss or gain in gallons.
13. Per cent of loss or gain in gallons.

$$\frac{100 \times \text{loss in gallons}}{\text{gallons in 40 strokes}} = ?$$

14. If there is a gain, explain why.

EXERCISE 29

Hydraulic Rams

EXAMINE hydraulic rams, comparing the following: construction, function, and adjustment of drive pipe, air chamber, dash valve, delivery valve, and delivery pipe.

REPORT

General Information

1. Give names and sizes of hydraulic rams.
2. Give names and addresses of manufacturers.

Drive Pipe

3. What effect on the air supply has the length of drive pipe?

4. How many times the height of the fall should be the length of the drive pipe?

5. What should be the diameter of the drive pipe in terms of the diameter of the discharge pipe?

6. How do the corresponding details of the machines studied compare with the answers to questions 3, 4, and 5?

Hydraulic Ram

7. Compare rams as to durability of materials entering into the construction.

8. Explain the difference between the single-acting and double-acting rams, and discuss the conditions under which each should be used.

9. Where is the overflow and what function does it perform?

10. How small a flow can be utilized?

11. What purpose does the automatic air valve serve? (See questions 3 and 4.)

12. Give the dimensions of the ram.

MISCELLANEOUS

13. Why are gate valves recommended for both drive pipe and discharge pipe?

14. What provision is made for guarding against the entrance of foreign matter into the drive pipe?

OPERATION

15. How can the ram be started?

16. What care is necessary?

17. Explain fully the principles governing the operation of the rams.

18. What is necessary when the air chamber becomes waterlogged?

Practical Problems

1. (*a*) How many gallons per minute must a spring deliver to raise 9 gallons per minute to a height of 60 feet, when the supply or drive water head is 8 feet? Efficiency about 57 per cent. (*b*) Same as (*a*) except for the substitution of 8 for 9, 50 for 60, and 10 for 8. Efficiency about 70 per cent.

2. The drive water supply in the spring is 12 gallons per minute. The height to which water is to be pumped is 45 feet. What is the necessary fall from the spring to the ram in order to supply the storage tank with 2.5 gallons per minute? Efficiency about 65 per cent.

NOTE.—See Ex. 30 for equation to be used for Problems 1, 2, and 3. Rememoer that $w_1 = (W - w)$.

3. The drive water supply is 7 gallons per minute; the fall is 10 feet; and the height to which water is to be pumped is 48 feet. How much water will be delivered per minute to the storage tank? Efficiency about 75 per cent.

4. What data should be given when ordering a ram?

EXERCISE 30

Testing Hydraulic Rams

Test: (*a*) After starting the ram, measure the amount of water delivered to the ram and the amount discharged in a period of ten minutes. Count the number of strokes per minute once every five minutes during the test. Measure the supply head, discharge head, and amount of waste water.

Repeat test.

(*b*) Same as (*a*) but change length of stroke.

Report: Follow the general outline as given under the instructions. Include data sheet and calculations of efficiency.

SAMPLE DATA SHEET

Name of Ram..................

Length of drive pipe.............
Diameter of drive pipe...........
Length of discharge pipe.........
Diameter of discharge pipe.......

Test No.	Drive Water Head.	Height of Discharge.	No. of Strokes per Minute.	Gals. of Water Delivered to Ram per Min.	Gals. Discharged per Min.	Ratio of Water Delivered to Water Supplied.

$$\text{Efficiency: } E=\frac{w(H-h)}{w_1h}.$$

E = efficiency;

w = water pumped in pounds;

H = head from ram to reservoir in feet or discharge head;

h = head from supply to ram in feet or supply head;

w_1 = water discharged through waste valve in pounds;

W = water from spring, in pounds.

EXERCISE 31

Eveners

EXAMINE two-horse, three-horse, and four-horse eveners, comparing the following: size of parts; construction, function, and adjustment of single-trees, double-trees, eveners, clips, and clevises.

REPORT

General Information

1. Give names of eveners, and of machines on which the eveners are used.
2. Give names and addresses of manufacturers.

Materials

3. What materials are used for the single-trees, double-trees, and eveners?
4. Of what materials are the clips made?

Construction

5. Tabulate lengths of single-trees, double-trees, and eveners.
6. What provision is made for increasing or for decreasing the length of lever arms?
7. Tabulate the distance between the end holes, and the distance the middle hole is in front or back of a line joining the end holes of the double-trees.
8. Why is the middle hole not in the line joining the two end holes?
9. How are the tugs, when slackened, kept hooked to the clips?

Operation

10. Make a sketch of one two-horse evener. By means of dotted lines show positions of each part of the evener when one horse is 8 inches ahead of the other.
11. Find the load for each horse in (10) if the team is exerting a pull of 300 pounds.

Miscellaneous

12. What suggestions can you make for the improvement of the eveners studied?

Practical Problems

1. On a close coupled four-horse evener, why should one double-tree be placed below and one above the evener?

2. Design a six-horse evener, four horses abreast and two ahead. Show length of parts.

EXERCISE 32

Manure Spreaders

Examine manure spreaders, comparing the following: width of track; height of box; capacity; and construction, function, and adjustment of frame, bed, wheels, apron, leveling device, wide-spread attachment, levers, gearing, seat, hitch, and beater.

REPORT

General Information

1. Give names and rated capacities of manure spreaders.
2. Give names and addresses of manufacturers.

Bed

3. Give the dimensions of the bed (depth, width, and length).
4. What is the capacity of the bed in cubic feet? In bushels? (1.25 cubic feet = 1 bushel.)
5. How does the height of the bed affect ease and time of unloading?
6. What advantages has a very low bed?
7. What effect has this construction on unloading: (*a*) bed sloping to the rear and (*b*) bed wider at the rear end than at the front end?

Wheels

8. What advantages have wheels that track? What disadvantages?

9. What advantages have wheels that do not track? What disadvantages?

10. How is the space in which a spreader will turn affected by a construction that permits the wheels to turn under the bed?

Apron and Apron Drive

11. Describe the construction of the apron.

12. How is the apron driven? Trace the transmission of power from the wheels to the apron.

13. What provision is made for keeping the apron tight? Clean?

14. How can the speed of the apron be changed? Give the number of apron speeds.

15. When spreading up a steep slope how is it possible to prevent racing of the apron?

Leveling Rake and Pulverizer

16. How does this device aid in breaking chunks?

Beater and Beater Drive

17. Describe the location and construction of the beater.

18. Compare the beaters as to strength of construction.

19. What provision is made for spreading wider than the bed?

20. Describe the mechanism by which beaters are driven.

Levers

21. How many levers are there? Explain the use of each.

22. Compare spreaders as to the ease of operation of levers.

Operation

23. How are chunks kept out of the beater when loading? Why is this necessary?

24. What advantage is there in running the cylinder when the apron is stopped?

25. How many revolutions will the cylinder make while the spreader moves 10 feet forward?

26. Determine smallest and greatest number of loads per acre that can be spread.

27. How are gears, chains and ratchets lubricated and protected from the dirt?

28. Describe in detail the methods of lubricating all bearings.

Practical Problems

1. Give the specifications for manure spreaders to be used under the conditions stated below. Two or three horses are available.

Farm A. Rolling land with ditches to cross. Manure spread upon 30 to 40 acres yearly.

Farm B. Level land with no obstructions. Manure spread upon 80 to 100 acres yearly.

2. How many loads of manure can be hauled per day with a 70-bushel manure spreader and a three-horse team, if the manure is spread on sod? On stubble? The average length of haul is 80 rods.

3. Same as 2 but with a 50-bushel spreader and two-horse team.

4. When spreading $6\frac{1}{2}$ loads to the acre with a 70-bushel manure spreader and three horses, how long will it take to spread manure over a 60-acre stubble field?

5. Under the following conditions: 70-bushel manure spreader costing $125; depreciation 10 per cent; interest on money invested 6 per cent; repairs $3 per year; storage $1 per year; man labor worth 20 cents an hour; horse labor worth 10 cents an hour. Three horses are used on the machine. The manure is spread at the rate of $6\frac{1}{2}$ loads per acre, one half on stubble, one half on sod. The spreader is used twenty days each year. What is the cost per day of spreading the manure? What is the total cost per year of spreading the manure?

6. What effect has the method of loading upon draft and pulverization?

EXERCISE 33

Wagons

EXAMINE wagons, comparing the following: construction, function, and adjustment of front and rear wagon gears, wheels, tires, hubs, spokes, felloes, axles, hounds, front and rear bolsters, standards, ironing, reach, brake, tongue, double-trees, stay chains, wagon box, and rub irons.

REPORT

GENERAL INFORMATION

1. Give names of wagons.
2. Give names and addresses of manufacturers.
3. Tabulate: size (light, medium, standard, and heavy) and type (farm, mountain, and valley) of wagons.

WHEELS

4. Compare the wheels as to diameter and length of hubs, and number of iron bands.
5. Tabulate: diameter of wheels (front and rear), width and thickness of tires, and number of spokes.
6. Describe the construction of that part of the spoke that fits into the hub. Into the rim.
7. Discuss merits of thick and thin, and sawed and bent felloes.
8. How are the spokes held in the rims? What effect does this method have on the splitting of rims and the loosening of spokes?
9. What provision is made to keep sand out of the space between the skeins and hubs?
10. Describe the Sarven Patent Wheel and explain the conditions under which it should be used.
11. Why are wooden wheels dished?
12. Why is front gather and pitch (bottom gather) necessary?
13. Measure the front gather.

Axles

14. Under what conditions are hollow axles, steel axles, and wooden axles with skeins, of the greatest use?

15. Show by a sketch the method of reinforcing the axle and of securing the skein to it.

16. Why use tapered skeins?

Gears

17. Show by sketches bent hounds and square hounds.

18. How are gears reinforced?

19. Which is the better style of gears, clipped or bolted? Why?

20. What purpose does the king bolt serve?

21. Compare bolster plates as to purpose and as to ease of removing king bolt.

22. What advantage in having a bolster plate wider than the bolster and sand board?

23. Describe bolsters and standards.

24. How are the front gears made for a stiff tongue, a half stiff, or a drop tongue?

25. What is the distance from center to center of axles when used under a standard box? Under a 14-foot hay rack? Under a 16-foot hay rack?

26. Tabulate: length, width, and height of lower box, top box and tiptop box. (Inside dimensions.)

27. What purpose do the grain cleats serve?

28. What prevents the wagon box from slipping either forward or backward on the bolsters?

Miscellaneous

29. What provision is made for flexibility of the reach when one wheel drops into a rut?

30. Why use stay chains on the double-trees?

31. Which style of brake is the better, the box brake or the gear brake? Why?

OPERATION

32. What arrangements are necessary if loose hay is to be hauled?

33. Describe the method of lubricating the wheels.

34. By what arrangement is it possible to make use of the gear brake when hauling with a rack wagon?

35. How should the wagon be loaded for travel over fairly smooth, level roads?

Practical Problems

1. Give specifications for wagons to be used under the conditions stated below:

Farm A. General farming in a comparatively level section. Maximum loads about 4500 pounds. Running gears used as much in the field as on the road.

Farm B. Grain farming in a level section. Maximum loads about 4500 pounds. Running gears used most on the road.

Farm C. Gears chiefly used for hauling feed, bundles, etc., around the farm.

Farm D. General farming in a mountainous country. Maximum loads about 5500 pounds.

2. The ratio between wheel and axle diameters equals 15. The coefficient of friction equals .08. (*a*) What force is required per ton to overcome the axle friction? (*b*) What force with an empty wagon weighing 1400 pounds? (*c*) What force with a loaded wagon (net weight of 3000 pounds)?

3. Show by a sketch how the diameter of wheels affect the draft of wagons. Explain.

4. What is the grade resistance of a wagon on a 5 per cent grade if the gross load equals 4000 pounds?

5. The rolling resistance per gross load of 3500 pounds plus axle friction is 97 pounds on a hard road. (*a*) What is the total draft when climbing a 10 per cent grade? (*b*) How much is each horse exerting if the team weighs 2800 pounds? (*c*) Compare this with the normal load a horse should pull.

6. The rolling resistance per gross load of 3250 pounds

(on a wet corn field) plus axle friction is 566 pounds. (*a*) What is the total draft when climbing a 5 per cent grade? (*b*) What per cent of his weight is each horse exerting if the team weighs 2800 pounds? (*c*) Compare this with the normal load a horse should pull.

7. Write out an order for a set of low wheels that are to be used on a thimble-skein wagon equipped with 44-inch front and 50-inch rear wheels.

EXERCISE 34

Potato Planters

EXAMINE potato planters, comparing the following: construction, function, and adjustment of frame, wheels, levers, hopper, fertilizer attachment, coverers, furrow opener, marker, and bearings.

REPORT

GENERAL INFORMATION

1. Give names of potato planters.
2. Give names and addresses of manufacturers.

HOPPER AND PLANTING DEVICE

3. What effect on the length of rounds has the size of the hopper?
4. By what means is bridging over of the seed in the hopper prevented?
5. Describe seed selecting devices.
6. How is the distance between the seed regulated?
7. What effect has the size of seed on accuracy of drop?
8. What advantages has sight feed?
9. Explain the method of driving the planting device.

FURROW OPENER

10. Describe the furrow opener.
11. Compare advantages and disadvantages of shoe, shovel, and double-disk furrow openers.
12. How does the position of the furrow opener affect the even depth of planting when the planting is in uneven ground?
13. How is the depth of the furrow regulated?

LEVERS

14. How many levers are there? Explain the use of each.

COVERING DEVICE

15. Describe the covering device.
16. How is the covering device adjusted?

OPERATION

17. How many men are needed to operate the machine?
18. Why is more than one operator considered necessary n certain types?
19. How many horses are necessary?
20. Describe the method of planting.
21. Describe in detail the methods of lubricating all bearngs.

MISCELLANEOUS

22. Which machine is more likely to tip over on side hills? Why?

Practical Problems

1. Give the specifications for a potato planter to be used n a 40-acre field. The land is undulating. One or two men re available.

2. How long will it take to plant 10 acres to potatoes, ows 32 inches apart, when (*a*) dropping by hand? (*b*) Using one-man planter? (*c*) Using a two-man planter?

EXERCISE 35

Potato Diggers

EXAMINE potato diggers, comparing the following: contruction, function, and adjustment of frame, wheels, elevator, hovel, shaker, levers, and hitch.

REPORT

GENERAL INFORMATION

1. Give names of potato diggers.
2. Give names and addresses of manufacturers.

Shovel

3. What is the purpose of the vine catcher?

4. How is the depth of the shovel adjusted? What are the limits of adjustment?

5. What is the method of sharpening?

Elevator

6. How are the potatoes elevated and cleaned?

7. Explain the operation of the elevator and the method of driving.

8. If the machine does not depend entirely upon the elevator for separation, describe the attachment.

9. What provision is made for separating potatoes from vines and weeds?

Wheels

10. How is slipping of wheels prevented on level and side hill surface? Describe these methods.

11. What attachments are used when transporting the machine?

12. Draw a sketch showing the method of transmitting power to the elevator.

Levers

13. How many levers are there? Explain the use of each.

Hitch

14. Describe the hitch.

15. How is a flexible connection obtained?

Operation

16. Describe in detail the methods of lubricating all bearings.

17. What bearings can be adjusted for wear?

Practical Problems

1. Give the specifications for potato diggers to be used under the conditions noted below. Two, three, or four horses are available.

Farm A. Five acres are planted to potatoes each year.

Farm B. Thirty acres of land easily worked are planted to potatoes each year.

Farm C. Twenty-five acres of level land hard to work are planted each year.

2. How many days will it take to dig 30 acres of Irish potatoes with a potato digger, and two, three, or four horses?

3. How many days will it take to pick up the potatoes after a potato digger if the yield per acre is 130 bushels?

4. Same as 3, but digging and picking up is by hand.

EXERCISE 36

Fanning Mills

EXAMINE fanning mills, comparing the following: construction, function, and adjustment of frame, hopper, sieves, screens, fan, and shoe.

REPORT

GENERAL INFORMATION

1. Give names of fanning mills.
2. Give names and addresses of manufacturers.

HOPPER

3. Why is an agitator needed?
4. How is the rate of feed regulated?
5. What effect on operation has capacity of hopper?

SHOES

6. Which machine has side shake? End shake?
7. How can the length of stroke be varied?
8. State number of screens and sieves the shoe will contain and describe the methods of making adjustments.

SCREENS

9. Tabulate: total number of screens, material, size, and shape of openings. Sketch shape of openings.
10. How are the screens numbered?

SIEVES

11. Tabulate: total number of sieves, material, size, and shape of openings. Sketch shape of openings.

12. How are the sieves numbered?

AIR BLAST

13. Compare mills as to diameter and width of fan.

14. How can the air blast be regulated or varied to meet different conditions of light or heavy seed or grain.

15. Of what use are the wind blinds? The wind boards?

16. Make a cross-section drawing showing: arrangement of sieves and screens; where each grade of grain comes out; how the blast is applied, expanded or restricted; and where the blast meets the grain.

OPERATION

17. Describe in detail the methods of lubricating all bearings.

18. On what physical characteristics (e.g., size, shape, or weight) does the machine depend in separating the grain?

19. Tabulate names of machines and capacities per hour.

20. What should be the r.p.m. of the drive pulley (or hand crank)?

EXERCISE 37

Operation of Fanning Mill

STUDY the operation of the mill assigned, by making the following tests:

1. Clean and grade 2 bushels of wheat.
2. Clean and grade 2 bushels of oats.
3. Clean and grade 2 bushels of alfalfa seed.
4. Separate the following mixture: 1 quart clover or weed seed, 1 peck of oats, and 1 peck of wheat.
5. When the grains mentioned above are not available use those furnished by the instructor.

Obtain scales, grain, and grain tester from tool room.

In making tests (1), (2), and (3), bear in mind that the object of these tests is to secure the best possible grade of grain

SAMPLE DATA SHEET

Name of Machine.......................... Grain..............................

Run.	Screen No.	Sieve No.	Original Grain.		First Grade.		Second Grade.		Tailings.	Total Minutes.	Bushels per Hour	R.P.M.	Opening of Feed.	Condition of Blast.
			Total Wt.	Wt. per Bu.	Total Wt.	Wt. per Bu.	Total Wt.	Wt. per Bu.	Total Wt.					

for seed. First select the screen which seems best suited to the grain. Try three sieves. The results will show which is the most desirable sieve to use.

A short preliminary test is necessary in order to determine the proper angle of the sieves, proper width of openings, proper r.p.m. and the proper arrangement of air blast.

Precaution: The person turning the machine should count the r.p.m. every few minutes, keeping it as near the standard as possible. If driven by belt, check speed with a speed counter.

After completing each test mix the grain together as it was before.

TEST 4

Arrange the machine to separate the mixture. Follow suggestions made for tests 1, 2, and 3.

Report: Follow the general outline as given under the instructions.

NOTE.—When through with the test, return the instruments, place the grain in a receptacle and clean up around the machine.

EXERCISE 38

Field Observation

Instruction: The machines assigned are to be studied while in operation. If possible each student should operate the machine. Special attention should be given to the function and adjustment of all parts. The comparison form of exercise for the same machine can be used as a guide.

Report: Follow the general outline as given under the instructions. Discuss briefly the functions and adjustment of the parts and the use to which the machine was put.

PART II

POWER FARMING MACHINERY

EXERCISE 1

Engine Moldboard Plows

EXAMINE engine moldboard plows, comparing the following: size; number of bottoms; construction, function, and adjustment of frame, wheels, platform, hitch, beam couplings, plow bottoms, suction, winging, gauge wheels, coulters, safety, and lifting devices.

REPORT

GENERAL INFORMATION

1. Give name of engine plows.
2. Give names and addresses of manufacturers.
3. Tabulate: the number, size, and type of plow bottoms.

FRAME AND WHEELS

4. Draw a plan view of each plow, showing an outline of the frame, the location of the lifting mechanism, hitch, and wheels.

5. Discuss the reasons for having the right-hand furrow wheel set vertically on some plows and in an inclined position on others.

6. Which wheel should furnish the power for the power lift? Explain fully.

If light duty,

7. By what construction is the lever lift feature obtained? Why is this important?

If heavy duty,

8. What effect on the accessibility of the wheels and the frame has the presence of the platform?

Hitch

9. Describe the construction of the hitch.

10. Why is it necessary to have a vertical range of adjustment?

11. What provision is made for changing the width of the right-hand furrow slice?

If light duty,

12. Where is the safety device and what does it consist of?

If heavy duty,

13. Why is it not possible to have chain connections the same length at all times?

Levers

14. How many levers are there? Explain the use of each.

If Power Lift

15. How is the clutch operated?

16. Explain fully the action of the power lift mechanism in raising and lowering the bottoms.

17. What effect on the operation of the plow has the position of the clutch?

If Lever Lift

18. What effect on the operation of the plow has the number of bottoms that are operated by one lever?

Beams and Plow Bottoms

19. Compare the plows as to ease with which the shares can be removed.

20. How can the plow bottoms be interchanged in case of breakage?

21. Measure the clearance between the share points and the road surface when the plows are ready for transportation.

If light duty,

22. How are the beams held in place?

If heavy duty,

23. Describe the safety device used, giving conditions under which they are necessary.

24. How can the winging of the bottom be changed?

25. What provision is made for taking up wear in the beam couplings?

COULTERS

26. Explain the method of attaching and of adjusting the coulters.

27. Draw a plan view and a side view showing the position of the share, coulter, and (if it is a heavy-duty plow) of the gauge wheel.

OPERATION

28. Describe in detail the methods of lubricating all bearings.

29. How should the coulter be adjusted for plowing in sod, in stubble, and in rocky ground?

30. How is the suction regulated?

31. How can the plows be backed up?

32. The tractor is heavily loaded and it is noticed that the front wheels tend to slide into the open furrow. What is the trouble? How can it be remedied?

33. Give the effects of too much side draft.

If light duty,

34. Where should the front wheels be when the clutch is released at the headland furrows?

35. What effect on the clearance has the depth of plowing when the bottoms are raised out of the ground by the self lift?

36. What adjustments are necessary to (*a*) throw more side draft upon the tractor? (*b*) Upon the plow?

37. Draw a sketch of an 80-acre field, 80 rods wide by 160 rods long, showing how to lay it off for plowing with a 3-bottom plow. Give measurements.

If heavy duty,

38. How does the wear of the break pins affect the suction of the bottoms?

39. What will cause a bottom on an independent beam gang to bob up and down?

40. How can one bottom be removed if the plowing is very difficult?

41. Why should the operator be very careful not to use a short hitch?

42. Explain the method of adjusting the hitch on a plow using the cross-chain hitch so that the side draft is thrown on both the tractor and the plow.

43. How can more of the side draft of No. 42 be thrown (*a*) on the tractor? (*b*) On the plow?

Practical Problems

1. Give specifications for engine gangs to be used under the conditions stated below:

Farm A. 12–25 tractor with plowing speed of $2\frac{1}{2}$ miles per hour. Land level and not extremely hard to plow.

Farm B. 10–20 tractor with a plowing speed of $2\frac{1}{4}$ miles per hour. Land slightly rolling and not extremly hard to plow.

Farm C. 20–40 tractor with a plowing speed of $2\frac{1}{4}$ miles per hour. Land level but very hard to plow.

2. A four-bottom engine gang requires a 700-pound pull per bottom, when plowing 6 inches deep under certain conditions. If the tractor travels at $2\frac{1}{2}$ miles per hour, what is the drawbar horse-power developed?

3. A tractor will develop 15 horse-power on the drawbar. The land is level. (*a*) How many bottoms can be pulled if plowing 6 inches deep and the draft per square inch of furrow slice is $4\frac{1}{2}$ pounds when traveling at $2\frac{1}{2}$ miles per hour?

(*b*) Same as (*a*) but draft per square inch of furrow slice equals $8\frac{1}{2}$ pounds.

4. Which tractor will cover the most ground in a day: (*a*) One pulling three bottoms at 2 miles per hour or one pulling two bottoms at $2\frac{3}{4}$ miles per hour? (*b*) Which requires the more horse-power, the draft per bottom being 500 pounds?

5. Write explicit directions for laying out a level field 160 rods square to be plowed with an 8-bottom gang. State how the ends and the corners will be finished.

EXERCISE 2

Engine Disk Plows

Examine engine disk plows, comparing the following: construction, function and adjustment of frame, wheels, hitch, running board, power lift, disks, scrapers, and bearings.

REPORT

General Information

1. Give names of engine disk plows.
2. Give names and addresses of manufacturers.
3. Tabulate: diameter, number, and distance apart, of disks.

Frame

4. How can the frame be narrowed or widened for fewer or greater number of disks?
5. Draw a sketch of the frame showing bracing and position of wheels.
6. How close is the frame to the surface of the ground when plowing 7 inches deep. Why is clearance important?
7. Why is a ring sometimes attached to the rear end of the frame?
8. What purpose does the running board serve?
9. Why do the wheels have triangular tires rather than oval tires as on the wheels of engine moldboard plows?
10. How many levers are there? Explain the use of each.

Hitch

11. Draw a sketch of the hitch, showing how it affects the front wheel.
12. Why is a rigid hitch desirable on a 3-disk plow?

Power Lift

13. Upon which wheel does the power lift act?
14. Explain the action of the power lift when in operation.

DISKS

15. How are the disks adjusted to turn the soil?

16. What kind of bearings are used in the disks?

17. How can the bearings be replaced in case of wear?

18. What effect on plowed ground has the distance apart of the disks?

SCRAPERS

19. Describe adjustment of the scrapers. Why is the adjustment necessary?

OPERATION

20. Describe in detail the methods of lubricating all bearings.

21. How must the disks be sharpened?

Practical Problems

1. Show by a sketch the hitch for a 2-section outfit.
2. Show by a sketch the hitch for a 3-section outfit.
3. Give the specifications for disk plows to be used under the conditions noted below:

 Farm A. Black land soil, level. A 20–40 tractor to furnish the power.

 Farm B. Sandy soil, level. A 12–25 tractor to furnish the power.

EXERCISE 3

Feed Mills

EXAMINE feed mills, comparing the following: construction, function, and adjustment of frame, hopper, feed crusher knives, quick release, safety device, mechanism, burrs, flywheels, and bearings.

REPORT

GENERAL INFORMATION

1. Give names and sizes of feed mills.
2. Give names and addresses of manufacturers.
3. Tabulate: rated capacities and power requirements.

Frame

4. Explain the method of belting up the machine.

5. Which mill has the most substantial frame? Why is this important?

6. Describe construction of each hopper; also compare the strength and capacity.

7. Explain how the divided hopper can be used.

8. What purpose do the crusher knives serve?

9. By what method is the grain carried to the burrs?

10. Describe the burrs used, designating each by name. (Simplex, duplex, flat, cylindrical, cone.)

11. What will happen if the burrs run together when the machine is empty?

Mechanism

12. Explain use of quick release and action of safety device in the prevention of clogging and of injury by foreign substances.

13. What is the function of the flywheel?

14. Which mill has the flywheel connected to the shaft by a clutch, break pin, key, or set screw? Discuss any merits of construction which are found.

15. How is wear of bearings taken care of?

16. Which method of delivering ground grain do you consider most convenient? Why?

Miscellaneous

17. Describe the action of the kafir head attachment.

18. Explain the use of the extra hopper.

Operation

19. Describe in detail the methods of lubricating all bearings.

20. Name the factors governing the capacity of the feed mills. (Refer to text and catalogs).

21. How can coarseness of grinding be regulated?

22 Engines of what size are required to drive these feed mills at their rated speed when grinding shelled corn?

23. What can each mill grind?
24. How can the burrs be replaced?
25. Why should an elevator be used?

Practical Problems

1. Give specifications for feed mills to be used under the conditions noted below:

Farm A. A 5 horse-power engine is available. The grains ground are shelled corn, ear corn, oats, and threshed kafir. Grinding usually does not take more than seven days each year.

Farm B. An 8 horse-power engine is available. The materials ground are corn, oats, kafir heads, and alfalfa. Grinding does not take more than twelve days each year.

2. A feed mill is purchased that has too great a capacity for the engine at hand. How can the operator use the engine to drive the feed mill?

3. How wide a belt is necessary if a feed mill is driven by a 6 horse-power engine? The belt pulley on the feed mill is 6 inches in diameter and makes 800 revolutions per minute.

EXERCISE 4

Corn Shellers

Examine corn shellers, comparing the following: size; mounting; method of driving; capacity; construction, function, and adjustment of frame, bearings, oiling devices, feeder, picker wheels, rag irons, cylinder, cleaning and separating devices, fan, blast regulator, grain elevator, and cob carrier.

REPORT

General Information

1. Give names of corn shellers.

2. Give names and addresses of manufacturers.

3. Tabulate: size, horse-power required, capacity, and kind of mounting of each machine.

Frame and Power Attachment

4. What kind of joints are used and how is the frame strengthened?

5. Why is a strong frame so essential?

6. What kind of power is used? Hand, belt, horse-power, or combined?

7. How are the inside wooden parts of the sheller protected from undue wear?

8. Which is preferable, the straight drive, right-angle drive, or both on the same machine?

Feeder

9. Describe the method of conveying or moving the ears to the picker wheels.

10. What means are provided for feeding the ears in straight?

11. How can the feeder be stopped with the machine running? When is this necessary?

12. How can the height of the feeder be adjusted and what is the effect on capacity as the angle between the feeder and the ground is changed?

13. What method is provided for changing the tension on the feeder chains?

Shelling Mechanism—If Spring Type

14. Describe and explain the use of beaters, picker wheels, bevel runners, and rag irons.

15. How are the rag irons adjusted?

If Cylinder Type

16. Describe the force feed and cylinder, and explain their functions.

17. What adjustments are necessary and how can they be made when the machine is in operation?

Separating and Cleaning Parts

18. Name the kind of cob rack used. (Vibrating, rod rack with rakes, or endless rack with thumpers.)

19. What is the difference between the shoeless and shoe methods of separation?

20. How are corn silks, cob ends, etc., separated from the shelled grain?

21. What is the " dustless " feature?

GRAIN ELEVATOR

22. How is shelled grain removed from the machine?

23. Discuss the merits of elevator chains and belts.

COB ELEVATOR

24. What are the means used to hold up the cob elevators?

25. Which elevator can be swiveled without stopping the machine?

26. Give lengths of each elevator.

OPERATION

27. Describe in detail the methods of lubricating all bearings.

28. What is necessary to make the sheller suited to shuck corn? (Applicable to cylinder shellers.)

29. How must the speed be varied when a smaller engine is used?

30. If the speed is changed on account of a change in the amount of horse-power available, what precaution is necessary in regard to the speed of the fan?

31. Trace the progress of an ear of corn through the machine until corn and cobs pass out. Explain operation of all parts.

Practical Problems

1. Give the specifications for corn shellers to be used under the conditions stated below:

    Farm A. The farmer wishes to shell his own corn, of which he raises about 40 acres yearly.

    Farm B. The farmer wishes to do custom work in a corn-growing section where there is little competition.

2. What factors must be considered first when selecting a corn sheller?

EXERCISE 5

Hay Balers

Examine hay balers, comparing the following: size; construction, function, and adjustment of frame, wheels, flywheel, clutch, gearing, pitman, plunger, self feeder, feed table, feeder arm, safety spring, hopper, feed opening, condenser, chaff grate, blocks, block setter, tucker, baling chamber, bale tension, signaling device, and equipment.

REPORT

General Information

1. Give names of hay balers.
2. Give names and addresses of manufacturers.
3. Tabulate: size, frame (steel or wood), power (motor press, or belt connected).

If Motor Press

4. Is a belt or chain used?
5. What are the advantages and disadvantages of belt, of chain, and of gear drives?
6. What means are used to tighten the belt?
7. Explain the operation of the clutch.
8. How can the engine be used without the baler?

If Belt Connected

9. Give the size and speed of the belt pulley
10. In which direction does the belt pulley turn?
11. How is the belt prevented from getting into the gears?
12. Explain the operation of the clutch.

Gearing

13. What are the means of stopping or starting gearing without affecting the engine?
14. In what way are flywheels connected to prevent damage in case of sudden stoppage?
15. Are the gears single or double, circular or elliptical in shape?

16. What is the shape of the pitman, of what material is it made, and how is it fastened to the gears and plunger?

17. How does the plunger support reduce friction?

Feeding Parts

18. Describe the self feeder.

19. What is the advantage of having a feeder arm work with a slow down-stroke and a quick up-stroke?

20. Why use a safety spring on the feeder arm?

21. Compare sizes and heights of the feed tables (or top of feed opening) above the surface of the ground.

22. Give dimensions of throat and of feed opening and explain how the size of this opening affects the ease and quickness of feeding.

23. Which machine is easier to feed from the ground?

24. Describe the blocks and the method of dropping.

25. How can the blocks be prevented from dropping at the wrong time?

26. Explain how the tucker works and discuss its advantages.

27. How is the time required for placing a new charge of hay affected by the movement of the plunger back and forth, and by the movement of the feeder head up and down?

Baling Chamber

28. Where is the chaff grate located? What purpose does it serve?

29. What effect has the length of baling chamber on the time allowed for tying?

30. How is the bale tied?

31. Where is the tension applied and why is it necessary?

Operation

32. Describe in detail the methods of lubricating all bearings.

33. Explain the function of the indicator.

34. Why is it better to feed small charges at each stroke of the plunger than large charges occasionally?

35. How must the feed chamber be fed?

36. Trace the progress of the hay from the feed table through the machine until it comes out in the form of a bale. Explain the operation of all parts. Also give the duties of each member of the gang needed with one of the balers.

Practical Problems

1. Give specifications for hay balers to be used under the conditions stated below:

Farm A. One hundred acres of alfalfa baled yearly.
Farm B. Baler used for custom work.

2. How many tons in a day can 6 men bale with a 14 by 18-inch hay baler driven by a 7 horse-power engine?

3. What is the daily cost of baling alfalfa hay if man labor is worth 25 cents an hour, and horse labor 10 cents an hour? A crew of 6 men is required to operate a 14 by 18-inch baler driven by an 8 horse-power engine. Two men operate sweep rakes. Bales weigh 60 pounds and are tied with 2 wires. Bale ties, 250 in a bundle, cost $1.85 per bundle. The hay baler costs $500. Depreciation is 10 per cent yearly. Money brings 6 per cent interest. The baler is used fifty days a year.

EXERCISE 6

Ensilage Cutters

Examine ensilage cutters, comparing the following: capaccity; power required; construction, function, and adjustment of truck, frame, feed table, feed rolls, levers, shear plate, cutter head, knives, bearings, shaft, fan, and elevator.

REPORT

General Information

1. Give names and sizes of ensilage cutters.
2. Give names and addresses of manufacturers.
3. Give capacity of and power required for each machine.

Frame

4. Describe the mounting of each machine.
5. Why is a substantial frame important?
6. Which frame do you consider the stronger? Why?

Feed Table

7. Explain the difference in construction between the traveling feed table, the plane feed table, and the grip-hook force feed.
8. What advantages has a force feed?
9. How is the feed table carried when the machine is on the road?
10. *How is the traveling table affected when the feed rolls* are reversed?
11. Why is the reversible arrangement desirable?

Feed Rolls

12. Give width of rolls for each cutter and describe their surfaces.
13. Why use feed rolls?
14. Describe the method of reversing the feed rolls.
15. How are the feed rolls driven and how is the upper roll made adjustable for uneven feeding?

Shear Plate

16. Explain the function of the shear plate.
17. Which machines have shear plates with more than one cutting edge?

Cutter Head

18. Classify the machines as to type and give speed of cutter heads.
19. Describe each type.
20. How can the knives be removed for sharpening?
21. Why is it essential to be able to adjust the knives?
22. Name machines on which the whole cutter head is adjustable with respect to the shear plate.
23. On which side are the knives ground?

24. Describe methods used in changing length of cut. What are the different lengths for each machine?

25. How can each machine be arranged to shred?

Fan

26. Describe the fan blades, the drum enclosing the fan, and the action of the fan.

27. How is the cut material delivered to the fan?

28. State number of revolutions per minute recommended by the manufacturers.

29. Will the machine deliver to a height of 60 feet as well as to 30 feet without increasing the speed of the fan?

30. Why is it dangerous to increase the speed above that recommended by the manufacturers?

31. If other types of elevators are used, give brief description.

Miscellaneous

32. How are the gears protected?

33. Which machine has the most simple arrangement of shafting and gears?

34. Explain the use of the recutting attachment.

35. How can the knives be sharpened at the machine?

36. What are the advantages and the disadvantages of the large, open flywheel and of the small, solid flywheel?

Operation

37. Describe in detail the methods of lubricating all bearings.

38. What means would you use to brace the machine against the pull of the belt?

39. Which end of the bundle should go into the machine first?

40. What is the relation between the amount of power and the height of the silo?

41. What provision is made for cleaning out the pipe and the fan drum if they should become clogged with cut fodder?

Operation

24. Describe in detail the methods of lubricating all bearings.

25. Which end of the stalks should first be fed into the machine?

26. How is the machine prepared for transportation?

27. Why is it necessary to cut the bands?

28. In what condition should the corn be when shredded?

29. Where is the release lever and how does it operate the clutch?

30. Why is it usually impracticable to run the fan at the same speed year after year?

31. Trace the progress of the stalks through the machine until ear and shelled corn and fodder pass out. Explain the operation of all parts.

Practical Problems

1. Give specifications for husker-shredders to be used under the conditions stated below. State also the power required.

Farm A. Eighty acres in corn yearly. No custom work.
Farm B. The machine to be used in a corn-growing section for custom work but competition is fairly strong.

2. The machine is set properly for medium weight corn. If heavy corn is then husked and shredded how must the speed of the fan be changed? Why is this necessary?

EXERCISE 8

Threshing Machines

Examine threshing machines, comparing the following: construction, function, and adjustment of wheels, axles, frame, feeder, band cutter, governors, cylinder, concaves, grate, beater, check board, rack, return pan, grain pan, chaffer, chaffer extension, wind blinds (gates), wind boards, shoe, grain auger, loader, tailings elevator, stacker, weigher, shafting, bearings, and method of belting.

REPORT

General Information

1. Give names of threshing machines.
2. Give names and addresses of manufacturers.
3. Tabulate: sizes of machines and explain method of specifying sizes.
4. What attachments has each machine? (Feeder, loader, weigher, bagger, stacker, clover attachment, recleaner, and brakes.)

Frame, Wheels and Axles

5. What machine do you consider to have the strongest frame?
6. What construction is necessary to prevent machines from being top heavy?
7. Should the front and the rear wheels track? Explain.
8. Which machine is equipped with solid axles? Hollow axles? Give your preference of these two types with reasons.

Feeder

9. Describe carriers (chain or belt) and means of driving.
10. Give advantages and disadvantages of these two types.
11. How can the speed of the bundle carrier be regulated when it is in motion?
12. Discuss the operation of the governors.
13. Describe the band cutter.
14. At what point on the periphery of the cylinder is the straw delivered?
15. What provision is made for retarding the bottom of the bundle while the upper portion is fed to the cylinder? Why is this essential?

Cylinder

16. Tabulate: diameter, number of bars, number of teeth, size of teeth, rated speed in revolutions per minute, peripheral velocity of teeth in feet per second, and diameter of cylinder pulley.

17. How does the diameter of the cylinder affect the number of bars and the number of teeth?

18. Explain the adjustment of bearings required to decrease the end play of the cylinder. How much end play is desirable?

19. What provision is made for easy accessibility of cylinder and concaves?

20. What is the difference, if any, in the construction of teeth for use in threshing hard wheat and soft wheat?

Concaves

21. How many rows of teeth can be placed in each machine at one time?

22. Explain how all adjustments are made.

Grates

23. Describe the construction (stationary or vibrating) of the grates.

24. Show by means of a cross-section sketch the relative position of the cylinder, the concaves, and the grate.

25. Give dimensions of the grate surface.

Beater

26. What purpose does the beater serve?

27. By means of what construction is straw prevented from wrapping around the beater?

28. What devices are used in addition to the beater for spreading straw on the rack?

Check Board

29. Where is the check board located?

30. What purpose does it serve?

Rack

31. Describe the construction and action of the rack on the straw.

32. If any additional devices are used for disintegrating bunches of straw, describe them.

33. How is motion (convex or concave) imparted to the rack?

34. Why is the width of separator greater than that of the cylinder?

GRAIN PAN (CONVEYOR)

35. Is the grain pan connected in any way with the rack? What advantage has this construction?

36. What effect has sag in the pan? How is this prevented?

37. Describe construction of and method of adjusting the chaffer and the chaffer extension.

38. Why can the working of a machine be judged quite accurately by the character and amount of tailings?

FAN AND SHOE

39. Is an over or under blast used? Discuss advantages and disadvantages of each.

40. Why are the ends of the fan boards not cut at right angles?

41. If an auxiliary fan is used, give its location and reasons for its use.

42. What purpose do the wind blinds (gates) serve?

43. Describe the wind boards, giving the number and the method of adjusting.

44. How is the end shake or cross shake motion imparted to the shoe?

45. Give the purpose and the method of adjustment of sieves and screens.

46. Compare the accessibility of the sieves.

SHAFTING, BEARINGS, AND BELTING

47. Compare the strength of the shafting; the accessibility and type of oilers; and adjustment of bearings for wear.

48. How many belts has each machine?

49. Why should the system of belting be simple and without sharp turns?

50. What belts can be tightened while the machine is in motion?

Loader

51. How can grain be delivered at either side of the machine? Why is this important?

52. What advantages has a machine weigher?

53. Describe the loaders, give preference and the reasons for your selection.

Stacker

54. Which machine has a wind stacker? An attached swinging stacker?

55. Describe the stacker and include an explanation of how it is operated. (Automatically or by hand.)

56. How are stackers prepared for the road?

Miscellaneous

57. Give the dimensions of a shed required to house one of the complete machines.

Operation

58. Describe in detail the method of lubricating all bearings.

59. What attachments make it possible to use a grain-threshing machine for hulling clover and alfalfa?

60. Which end of the bundle should be fed to the machine first?

61. In threshing a certain field of wheat, it is noticed that many heads are passing through the blower. What could be the causes?

62. The threshing machine operator observes that too much grain is going back through the tailings elevator. Further examination discloses the fact that the grain is coming over the shoe sieve. What adjustment is necessary?

63. Same as 62 except that grain comes through the chaffer extension.

64. What causes cracked grain?

65. How far back on the chaffer (conveyor sieve) should the wind board throw the strongest blast? Where will the blast then pass through the shoe sieve?

66. What are the causes of failure to separate the grain from the straw?

67. How can the operator determine if too much grain is passing out with the straw?

68. Explain the method of setting a separator.

69. In case of fire what is the quickest way to get the machine out of danger?

70. Trace the progress of bundles from the time they are placed on the feeder until the grain and straw have passed out of the machine. Explain the operation of all parts.

Practical Problems

1. Give the specifications of threshing machines to be used under the conditions noted below. Also give the size of tractor necessary to drive the machine.

A. Seven farmers own a threshing outfit coöperatively. Each raises from 100 to 150 acres of grain yearly.

B. Individual outfit for a farmer that raises 240 acres of wheat yearly.

C. Custom machine in a locality where there is considerable competition.

2. How should the threshing machine be set when the wind is from the southwest?

3. After being set as in 2, the wind changes to south of west. How must the wind blinds be adjusted?

4. It is noticed that the load on the shoe sieve is a little to one side. What adjustment other than leveling the separator will practically relieve this situation?

5. The machine has been standing in one place for several days and the ground is rather soft. What is the easiest method of moving the machine from this position?

6. How should the hood and the blower pipe be handled to get the best straw pile?

7. Wheat yielding 23 bushels to the acre is being threshed by an outfit operated by a crew of eighteen men. (*a*) How many bushels per day can be threshed? (*b*) How long will it take to thresh the wheat grown on 160 acres?

OPERATION

23. Describe in detail the methods of lubricating all bearings.
24. How is the wagon prevented from being raised too high?
25. Why is it advantageous to have the speed of the receiving hopper variable?
26. Explain completely the processes of unloading and elevating grain.
27. What must be done to the screen section before small grain can be elevated?
28. What is the least angle with the horizontal at which the elevator can be used for grain?
29. Trace the progress of the grain from the wagon to the grain bin. Explain the operation of all parts.

Practical Problems

1. Give the specifications for elevators to be used under the conditions stated below. Either a gas engine or a horse-power is available.

 Farm A. Ear corn and oats are the only grains.
 Farm B. Ear corn, wheat, and shelled corn are the grains.

2. What is the greatest height at which grain can be discharged when using a 36-foot elevator?
3. What is the greatest height at which ear corn can be discharged when using a 34-foot elevator?
4. What is the greatest height at which grain can be discharged when using a 40-foot elevator?

EXERCISE 11

Upright Grain Elevators

EXAMINE grain elevators, comparing the following: construction, function, and adjustment of wagon dump, elevator boot, elevator, delivery spout, and bearings.

REPORT

General Information

1. Give names of elevators.

2. Gives names and addresses of manufacturers.

3. Tabulate: style of dump, height of elevator, and style of delivery spout.

Dump

4. Where is the boot and the dump located with respect to the driveway?

5. Describe the dump and explain its operation when unloading.

6. Give advantages and disadvantages of the overhead lift.

Elevator

7. How far apart are the cups?

8. What effect on operation has the capacity of cups?

9. How can the elevator chains be replaced?

10. Explain method of tightening the elevator chains.

11. What provision is made to take care of the grain when the grain begins running out of the wagon too rapidly?

12. How can the chain links be replaced?

Delivery Spout

13. Explain how the grain is delivered to the spout from the elevator.

14. What must be the shape of the cupola in order to contain the upper part of the elevator and of the delivery spout?

15. How can the grain and ear corn be delivered to all parts of the granary?

Miscellaneous

16. Describe the source of power and method of use.

Operation

17. Describe in detail the methods of lubricating all bearings.

18. Trace the progress of the grain from the wagon through the elevator to the bin. Explain the operation of all parts.

Practical Problems

1. Give the specifications for upright grain elevators to be used under the conditions stated below. A 3 or 4 horse-power gas engine is available. Include dimensions of driveway, of granary.

Farm A. Ear corn, wheat, and other grains are to be elevated. A pit cannot be dug and the driveway is only 9 feet high.

Farm B. All grains are to be elevated. It is possible to dig a pit.

2. How much wheat can be elevated in an hour by each of the machines studied?

EXERCISE 12

Power Sprayers

EXAMINE power sprayers, comparing: size and capacity of pump and tank; construction, function, and adjustment of truck, engine, power transmission, pump, pump valves, cylinder lining, plunger, air chamber, pressure gauge, relief valve, tank, agitator, tank filler, tower, suction strainer, suction hose, discharge hose, hose couplings, extension rods, and nozzles.

REPORT

GENERAL INFORMATION

1. Give names of sprayers.
2. Give names and addresses of manufacturers.
3. Tabulate: size of pumps and capacity of tank.

TRUCK

4. Which frame seems to be the strongest? The weakest? Why?

5. Give radius of smallest circle each machine can be turned in. Why is this important?

6. Compare machines as to chances of their miring in wet ground. (Consider total weight with tank filled, diameter of wheels, and width of tires.)

Engine

7. Tabulate the following: h.p., r.p.m., number of cylinders, method of cooling, and kind of carburetor.

8. How are the governor parts protected from jarring or shaking loose?

9. How can the engine be removed for use elsewhere?

10. Power transmission—direct gear with or without walking beam, connecting rod (yoke), or belt. Show by sketch.

11. If belt driven, how is belt slippage prevented?

Pump

12. How are engine and pump fastened to base so they can not become out of line?

13. On which sprayers can cylinders be removed for repairing or cleaning?

14. Cylinder linings are of what materials. Why use these?

15. Name types of valves used. Give your preference, with reasons.

16. If plunger pump, how many cylinders has each machine? (Single, duplex, or triplex.)

17. Of what type is the pressure regulator?

18. How is air supplied to the air dome?

19. Why use a relief valve and pressure gauge? Give their location.

20. What facilities are there for draining cylinders?

Tank

21. State whether of wood or steel. If of steel, how is it protected from the action of solutions?

22. What purpose does a manhole serve?

23. What apparatus is used in filling tanks?

24. How can tanks be drained?

25. Name the types of agitators and the method of driving.

26. Compare the methods of removing the suction strainer. Specify time necessary, convenience, and ease.

Towers

27. Give location on frame, method of attachment and removal, and height of platform above surface of ground.

28. What safeguards are used to prevent the operator from falling off the platform?

Spraying Parts

29. How many lines of hose can be used on each sprayer?

30. On which machines can one or more than one line of hose be shut off without affecting supply to other lines? How is this done?

31. Compare the diameter, length, number of ply, and quality of hose used.

32. Of what material are the extension rods?

33. Describe the action of the cut-offs on extension rods.

34. Why are these rods necessary?

35. Compare rods as to ease of handling, length, weight as affected by material, and construction.

36. Describe the nozzles used and state concisely the amount of pressure to be used and form of spray obtained from each type of nozzle.

Miscellaneous

37. Compare machines as to top-heaviness, frequency of stops necessary for oiling, and oiling devices.

Operation

38. Describe in detail the methods of lubricating all bearings.

Practical Problems

1. Give specifications for power sprayers to be used under the conditions noted below:

   Farm A. Orchard of 30 acres. Height of trees 20 feet, spread 19 feet, land hilly.

2. How many days will it take to spray 400 trees, the height of which is 20 feet and spread 19 feet, if 2 men use a power sprayer with a 180-gallon tank?

EXERCISE 13

Cost of Operation *

Follow the outline given below in preparing the exercise assigned.

Cost of Baling Hay

Directions: Obtain data, by observing the outfit at work at least for a period of two hours. The following factors must be taken into account: Condition and kind of hay, surface of field, weather, size and make of baler, source and amount of power, duties of each man belonging to the outfit, number of horses, average weight of bales, number of tons baled per hour, and time lost per hour due to any cause.

Report: Follow the general outline as given under instructions. Calculate cost of operating outfit for ten hours, and total cost per ton of hay. Consider man labor worth 25 cents an hour, horse labor 10 cents, unbaled hay at local price. Depreciation can be taken at 10 per cent and interest at 7 per cent. Instructor will give class an estimate of the first cost of machine. Include suggestions for decreasing the cost of baling.

* This exercise can be assigned for such operations as filling silos, threshing, shredding, corn shelling, etc.

SUMMARY OF WORK FACTORS FOR OPERATION WITH FIELD MACHINERY[1]

Operation or Implement.	Power Unit (Number of Horses).	Daily *Duty per* Foot of Width.	*Range of* Reported Widths.	Most *Usual* Width per Horse.
		Acres		Feet
Walking plow	2	1.62	8 to 14 inches	.50
Walking plow	3	2.00	10 to 16 inches	.44
Sulky plow	2	1.61	10 to 16 inches	.58
Sulky plow	3	2.13	12 to 16 inches	.44
Sulky plow	4	2.23	14 to 18 inches	.33
Gang plow	4	2.08	18 to 28 inches	.58
Gang plow	5	2.21	24 to 28 inches	.47
Gang plow	6	2.20	24 to 32 inches	.39
Traction engine gang	15–60 h.-p.	2.00	4 to 30 feet	.33
Spike-tooth harrow:				
On fresh plowing	2	1.40	6 to 12 feet	4.00
On well-packed land	2	1.60	6 to 12 feet	4.00
On fresh plowing	3	1.50	8 to 16 feet	3.50
On well-packed land	3	1.80	8 to 16 feet	3.50
On fresh plowing	4	1.70	10 to 26 feet	4.25
On well-packed land	4	2.00	10 to 26 feet	4.25
Spring-toothed harrow:				
On fresh plowing	2	1.20	4 to 8 feet	3.00
On well-packed land	2	1.40	4 to 8 feet	3.00
On fresh plowing	3	1.30	5 to 10 feet	2.33
On well-packed land	3	1.60	5 to 10 feet	2.33
On fresh plowing	4	1.50	6 to 12 feet	2.00
On well-packed land	4	1.70	6 to 12 feet	2.00
Disk harrow:				
On fresh plowing	2	1.10	4 to 8 feet	3.00
On well-packed land	2	1.20	4 to 8 feet	3.00
On fresh plowing	3	1.20	6 to 10 feet	2.25
On well-packed land	3	1.50	6 to 10 feet	2.25
On fresh plowing	4	1.60	6 to 10 feet	2.00
On well-packed land	4	1.90	6 to 10 feet	2.00
Land roller	2	1.60	5 to 12 feet	4.00
Land roller	3	1.65	5 to 12 feet	2.00
Land roller	4	1.75	8 to 16 feet	2.50

[1] Bulletin No. 3 of the United States Department of Agriculture.

The figures in this table are based upon certain fixed units of width. In column 3 is the daily duty per foot of width of implement and in column 2 the number of horses used. If for example, the farmer wishes to know what he should reasonably expect from an 8-inch plow drawn by two horses, he needs only to multiply the 1.62 by $\frac{8}{12}$. The result will be the daily duty of a two-horse walking plow that is 8 inches wide. For a 14-inch plow multiply 1.62 by $\frac{14}{12}$.

SUMMARY OR WORK FACTORS FOR OPERATION WITH FIELD MACHINERY—(*Cont.*)

Operation or Implement.	Power Unit (Number of Horses).	Daily Duty per Foot of Width.	Range of Reported Widths.	Most Usual Width per Horse.
		Acres		Feet
Grain drill	2	1.40	4 to 8 feet	3.25
Grain drill	3	1.50	6 to 10 feet	2.50
Grain drill	4	1.75	6 to 12 feet	2.25
Grain drill	6	1.90	8 to 12 feet	1.75
Corn or cotton planter:				
1-row	1	2.20	36 to 48 inches between rows	3.00
1-row	2	3.00		1.50
2-row	2	3.75		1.50
Covering seed potatoes	1	2.00	24 to 32 inches between rows	2.00
Covering seed potatoes	2	2.50		2.33
Marking planting rows	1	1.50	3 to 12 feet	3.00
Marking planting rows	2	2.00	3 to 12 feet	6.00
Potato planter:				
1-man	2	2.35	24 to 32 inches between rows	2.33
2-man	2	2.10		2.33
Lime spreader	2	1.10	6 to 12 feet	4.00
Fertilizer drill	2	1.30	5 to 10 feet	3.00
Fertilizer drill	3	1.40	6 to 12 feet	2.66
Field sprayer	1	1.10	3 to 4 rows each trip	11.00
Field sprayer	2	1.25		6.00
Mowing hay	2	1.60	4 to 7 feet	2.50
Raking hay	1	1.50	6 to 12 feet	9.00
Raking hay	2	1.60	8 to 16 feet	6.00
Tedding hay	1	1.40	6 to 8 feet	7.00
Tedding hay	2	1.70	6 to 10 feet	4.25
Grain binder	3	1.85	4 to 7 feet	2.00
Grain binder	4	2.15	5 to 8 feet	2.00
Grain binder	5	2.25	5 to 8 feet	1.66
Grain header	4	2.10	10 to 12 feet	3.00
Grain header	5	2.20	10 to 12 feet	2.25
Grain header	6	2.30	12 to 14 feet	2.33
Corn binder	3	2.00	Rows 36 to 48 in. (av. yield)	1.50
Cultivating	1	4.25		
Cultivating	2	6.75		
Knapsack sprayer	....	1.00		
Wheelbarrow seed sower	....	1.40	10 to 16 feet	
Hand corn planter	....	1.30	36 to 48 inches between rows	

PART III

FARM MECHANICS

CHAPTER I

ROPE

1. **How to Uncoil Rope:** Start with the end found in the center of the coil. Pull the end out and uncoil in the opposite direction to the motion of the hands of a clock. If it uncoils in the wrong direction, turn the coil over and pull the same end through the center of the coil and out on the other side. If properly uncoiled there will be very few snarls or twists in the rope.

2. **Care of Rope:** Keep the rope in a dry place. Do not leave it out in the rain. If a rope gets wet, stretch it to dry.

Tie or wrap the ends of the rope so thay will not unravel.

3. **Factors Governing Strength:** The strength of a new rope of a given size depends upon (1) kind of fiber used, (2) quality of fiber, (3) workmanship, (4) effect of preservatives on fibers, and (5) number of strands. No accurate rule can be given for calculating the strength. Any table of strength given is only approximately correct. The strength of a rope is decreased by age, exposure, and wear.

The breaking strength of a rope is the weight or pull that will break it. In order to protect life and property when lifting heavy objects the safe load on a rope must be much less than the breaking strength. The safe load is usually considered one-sixth of the breaking strength.

6. **Wall Knot with Crown:** For ends of halter ropes and for chest handles, as the knot will not pull through small openings.

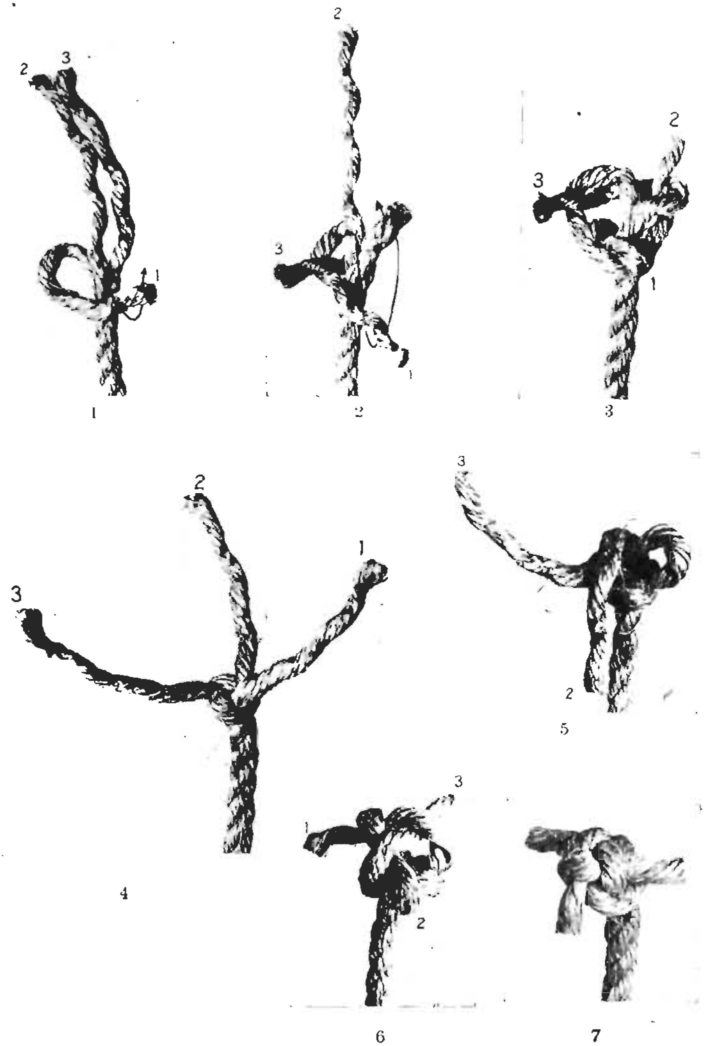


PLATE IV.—Wall Knot with Crown.

7. **Walker Knot:** *Used like the wall knot with crown.*

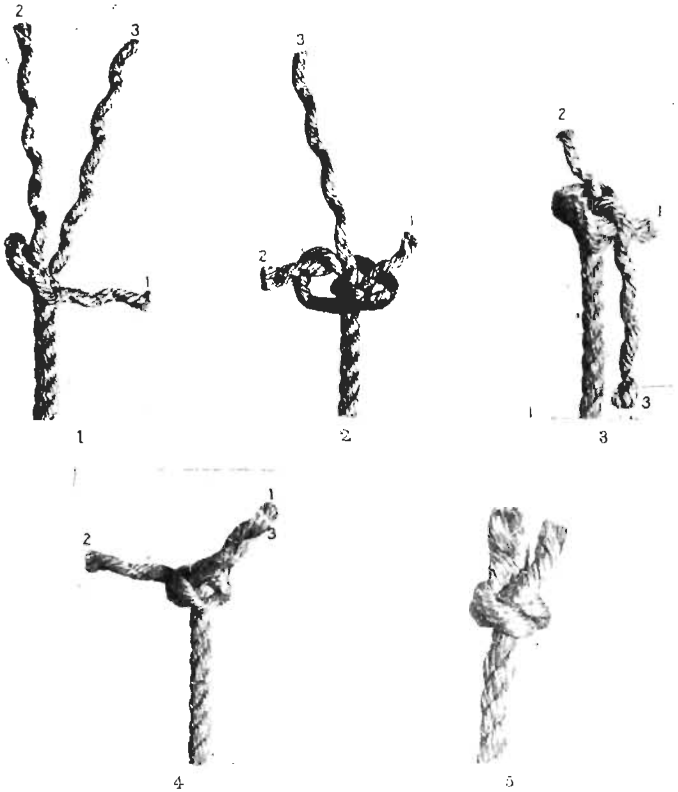


Plate V.—Walker Knot.

8. **Figure Eight Knot:** For knob or hand hold. Will prevent end of rope from slipping through a block.

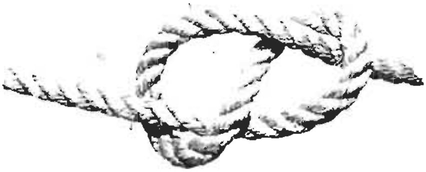


Plate VI.—Figure Eight Knot.

9. **Overhand Knot:** Use like the figure eight knot.

Plate VII.—Overhand Knot.

10. **End Splice:** This is a very good method when a slight enlargement of the end is not objectionable. This splice makes the end of the rope more rigid than do the knots.

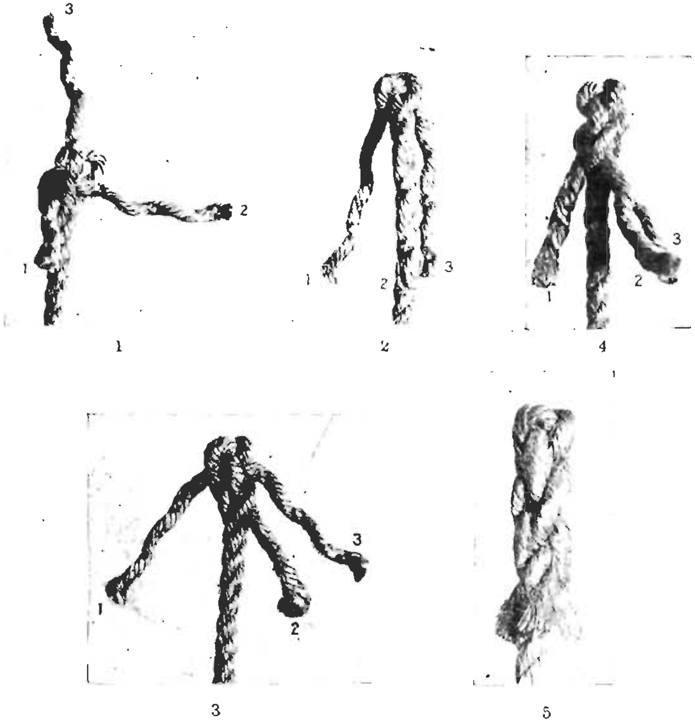


Plate VIII.—End Splice.

Loops at the Rope's End

11. **Bowline Knot:** Will neither slip nor pull tight. It can always be untied very easily. Sometimes called the King of Knots.

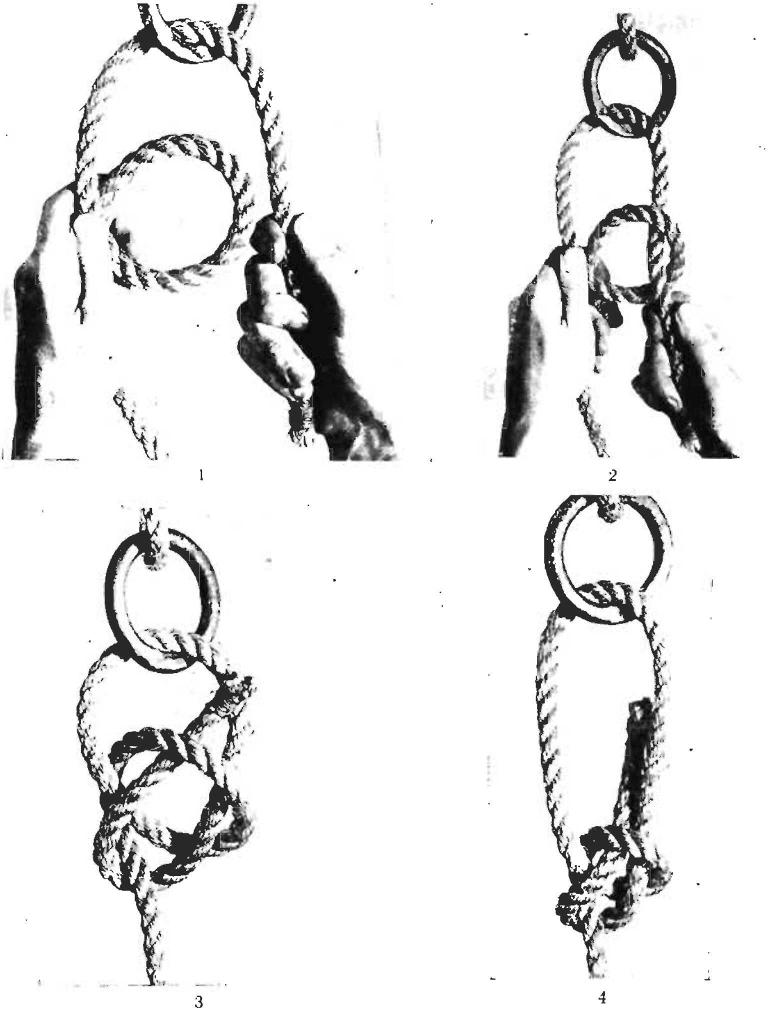
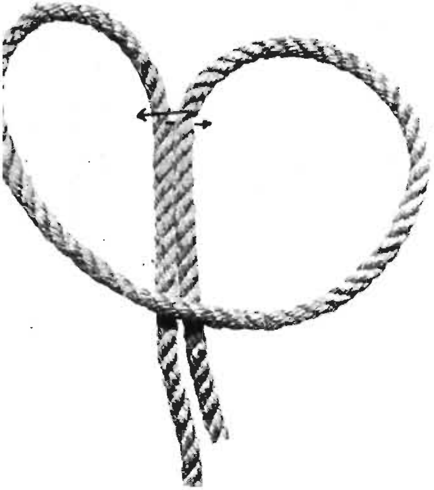


Plate IX.—Bowline Knot.

12. Flemish Loop: A permanent loop that will not slip.



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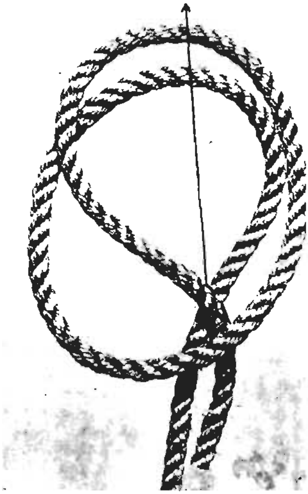

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PLATE X.—Flemish Loop.

13. **Slip Knot:** A loop that will tighten around an object.

PLATE XI.—Slip Knot.

14. **Midshipman's Hitch:** A knot which is nearly as strong as the rope.

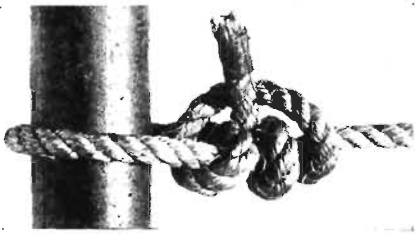


PLATE XII.—Midshipman's Hitch.

15. **Spliced Eye:** For fastening a rope permanently into a ring or eye. For making a permanent loop at one end of a rope.

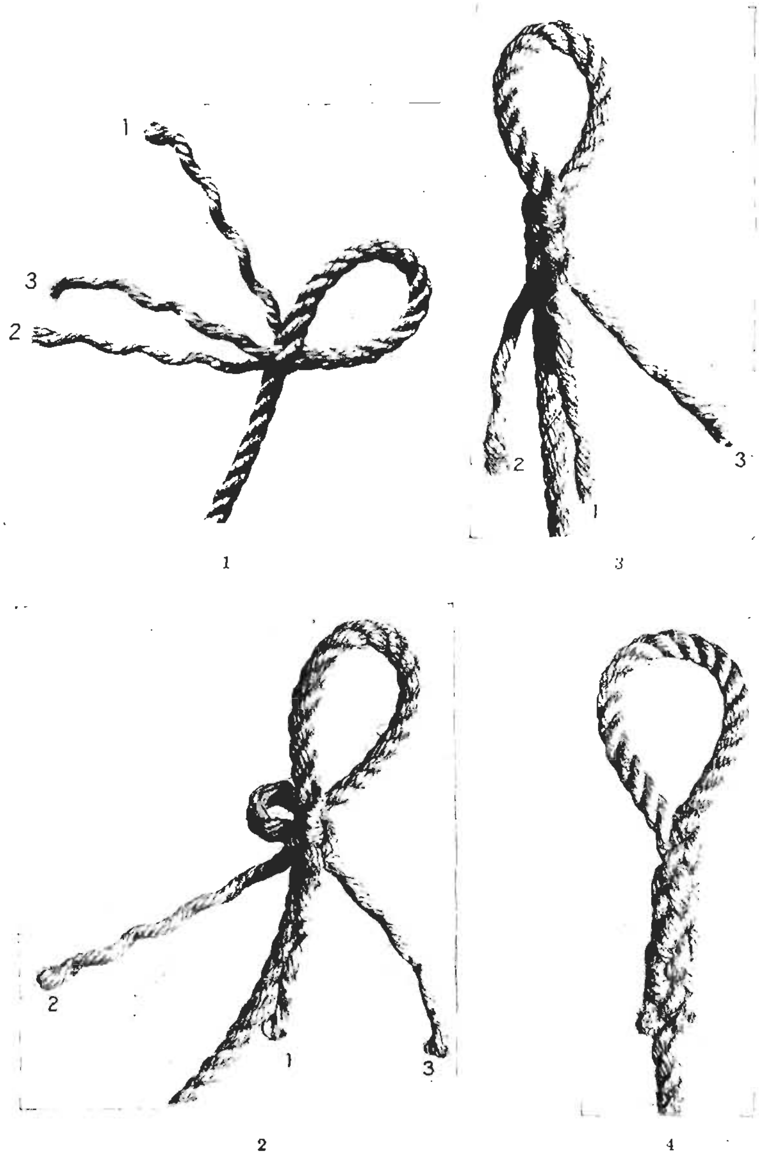
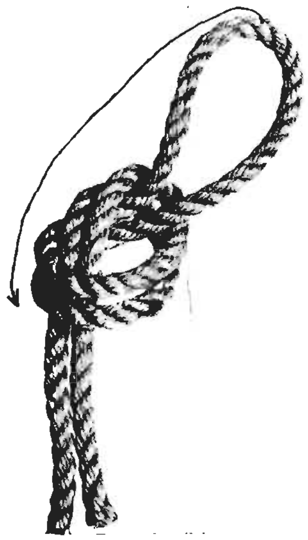


Plate XIII.—Spliced Eye.

Loops between the Rope's Ends

16. Double Bowline: Will not pull tight or slip.



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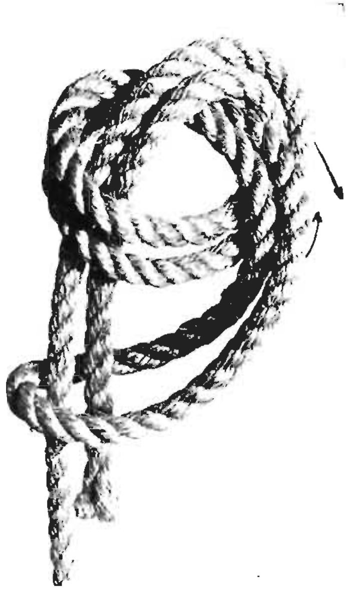

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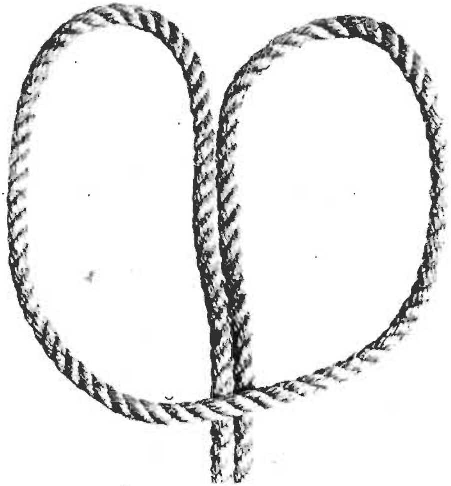
17. Spanish Bowline: For making two single loops close together at some point in a rope.



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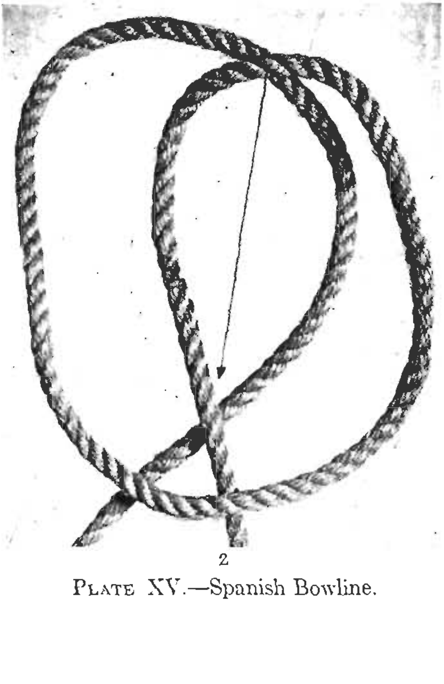

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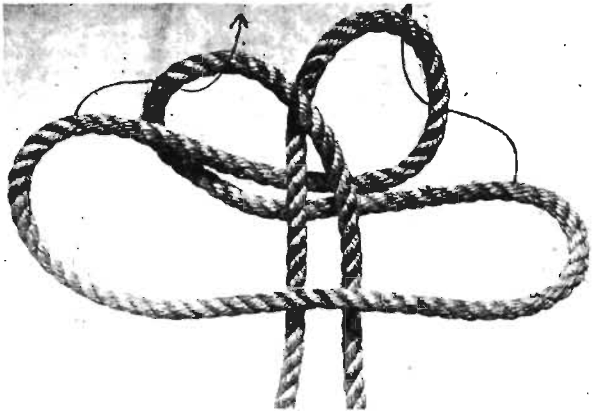
Plate XV.—Spanish Bowline.



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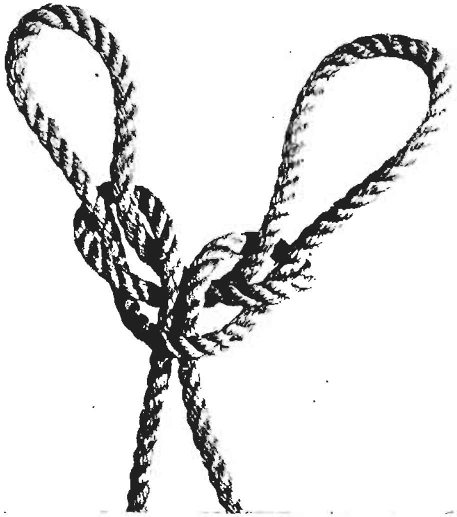

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PLATE XV.—Spanish Bowline. (*Continued.*)

18. **Harness Hitch:** Used when it is desirable to make a loop at a point in the rope and still pull either on both ends or on one end of the rope.

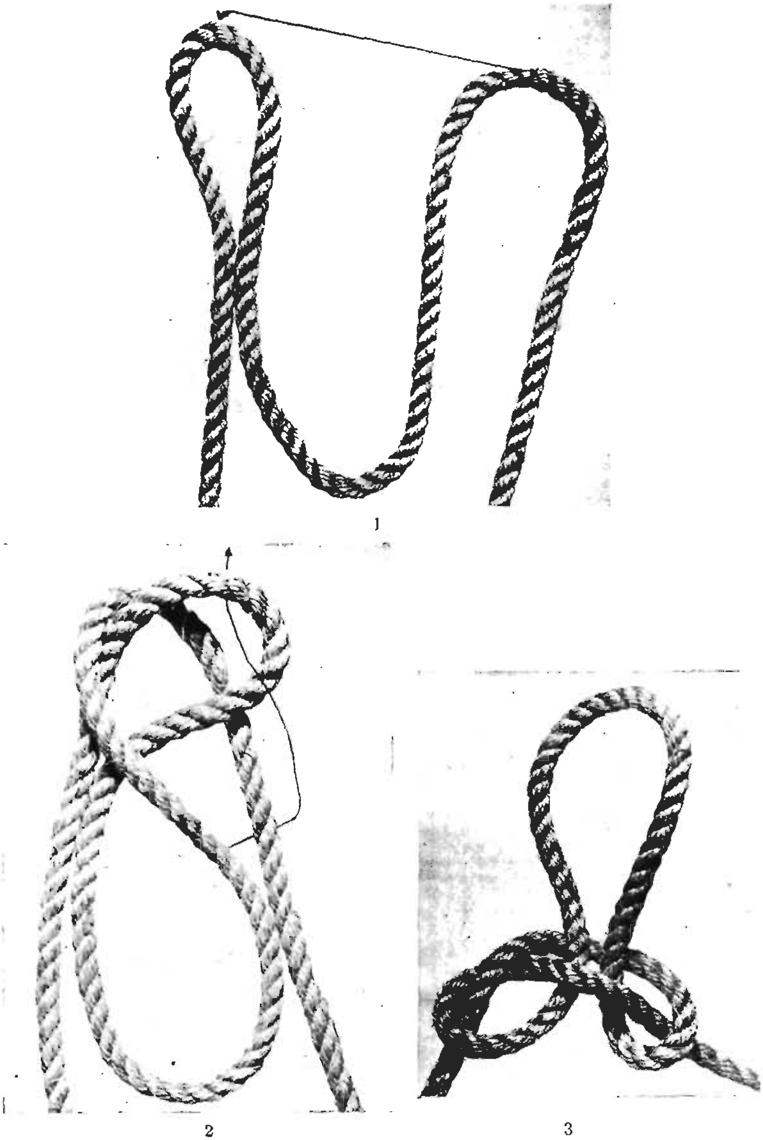

PLATE XVI.—Harness Hitch.

19. Farmer's Loop: Used like the Harness Hitch.

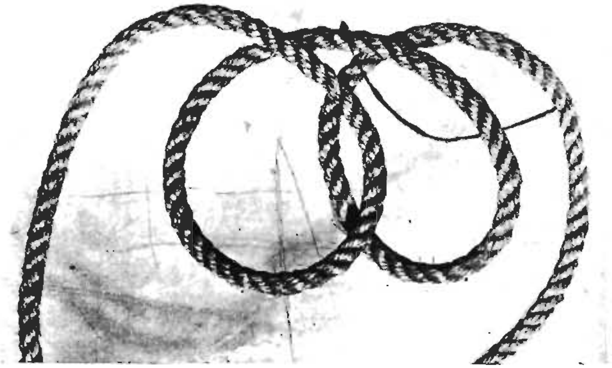

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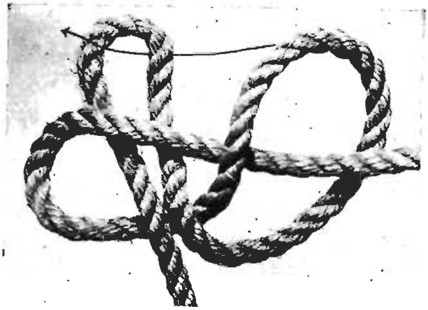
PLATE XVII.—Farmer's Loop.



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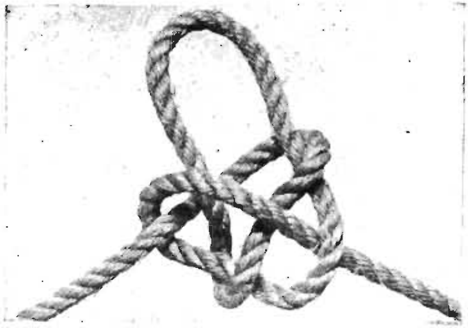

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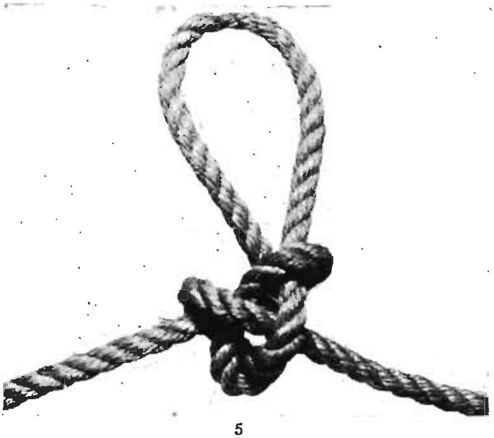


5

PLATE XVII.—Farmer's Loop. (*Continued.*)

Knots for Tying Ropes Together

20. **Square Knot:** For joining ropes of the same size. t will not slip and can be untied rather easily except when small opes are tied together and the knot is drawn tight. To untie, ıpset knot by taking one end of rope and its standing part and ›ull them in opposite directions. This knot should always ›e used in preference to the granny knot or the false square :not. Good for uniting binder twine.

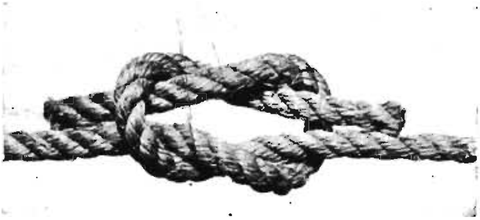


Plate XVIII.—Square Knot.

21. **Granny Knot:** A dangerous knot to use as it will slip ,nd is hard to untie.

Plate XIX.—Granny Knot.

22. **False Square Knot:** Unlike the true square knot it is ·ery likely to slip.

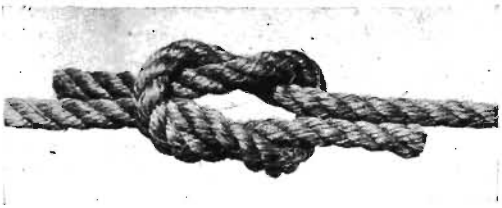


Plate XX.—False Square Knot.

23. Weaver's Knot: For joining ropes of unequal size, but best used in joining straps, twine, or thread.

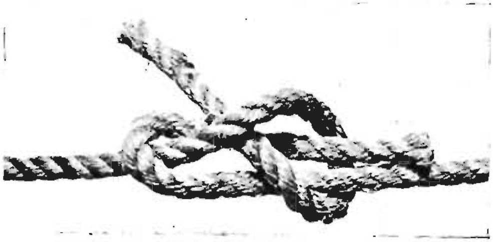


PLATE XXI.—Weaver's Knot.

24. Modified Weaver's Knot: For tying lines together.

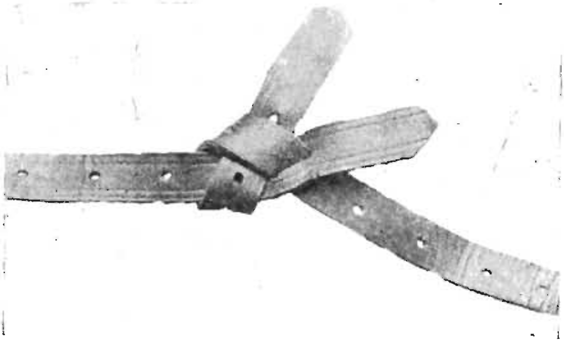


PLATE XXII.—Modified Weaver's Knot.

TO SHORTEN A ROPE

25. **Sheepshank:** This is only for temporary use.

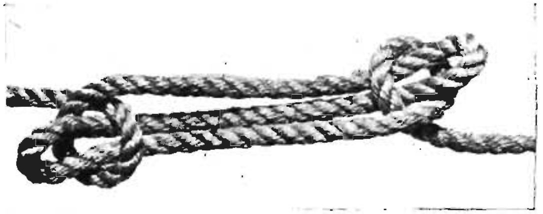
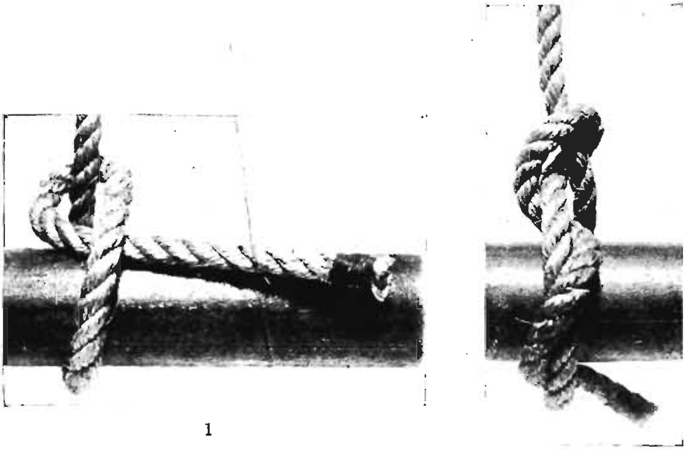


PLATE XXIII.—Sheepshank.

Hitches

26. **Timber Hitch:** It will not slip under a pull and can easily be loosed when the strain is taken off. For dragging and lifting logs and timbers and for securing the end of the rope.



1 2

Plate XXIV.—Timber Hitch.

27. **Timber Hitch and Half Hitch:** Make the half hitch first, then the timber hitch. Better than the timber hitch but not as easily removed. Used like timber hitch.

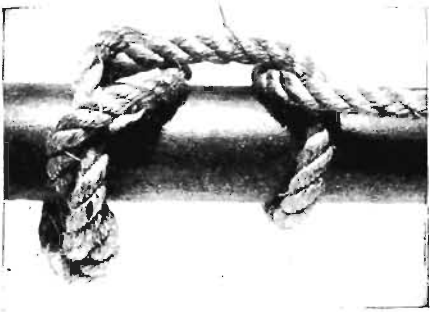
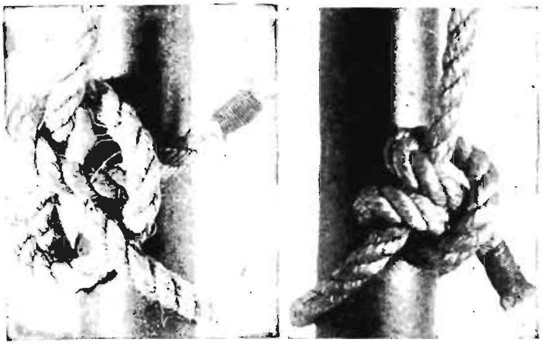


Plate XXV.—Timber Hitch and Half Hitch.

28. **Two Half Hitches:** A good fastening around a post or timber, or around the standing part of the rope.



Right Method   Wrong Method

PLATE XXVI.—Two Half Hitches.

29. **Cat's Paw:** After it is drawn tight the user can pull on either end of the rope. For fastening a rope to a hook.

2

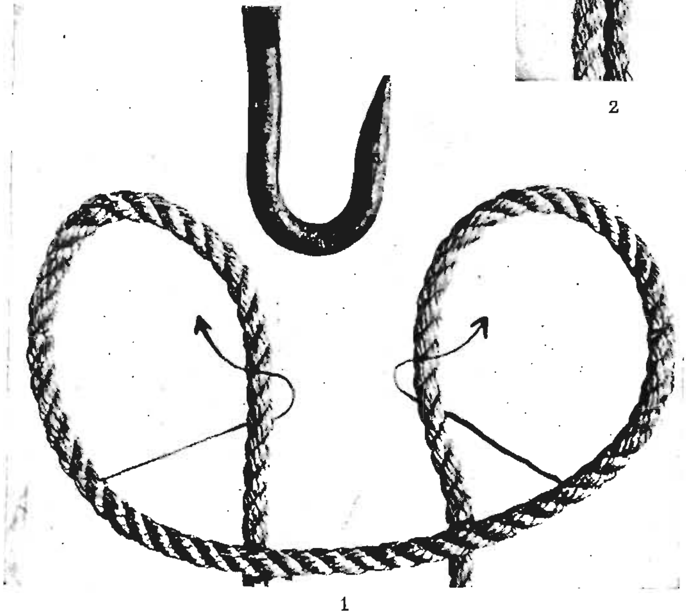


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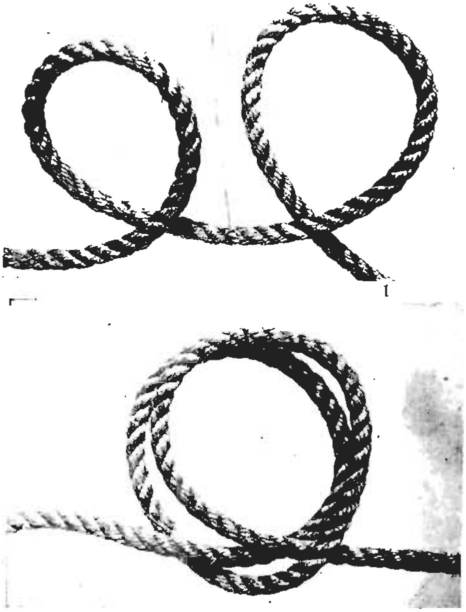
PLATE XXVII.—Cat's Paw.

30. **Clove Hitch:** First method: When hitch can be passed over the end of a post.

Second Method: When the hitch can not be passed over the end of a post.

The user can pull in any direction on the long end.

Used for fastening a rope to a post, timber, pipe, or mast.

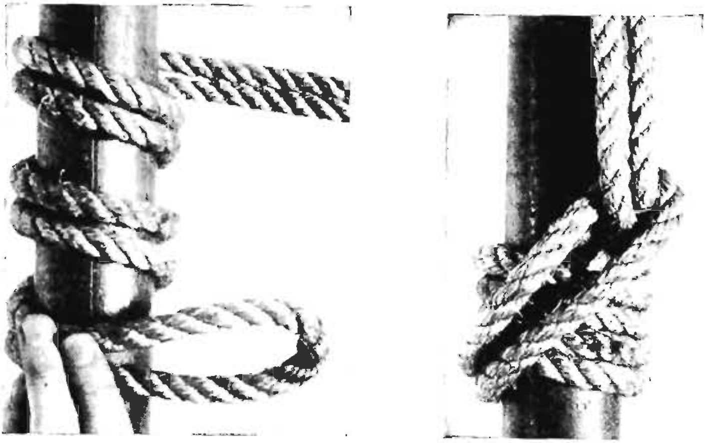


First Method 2

Second Method

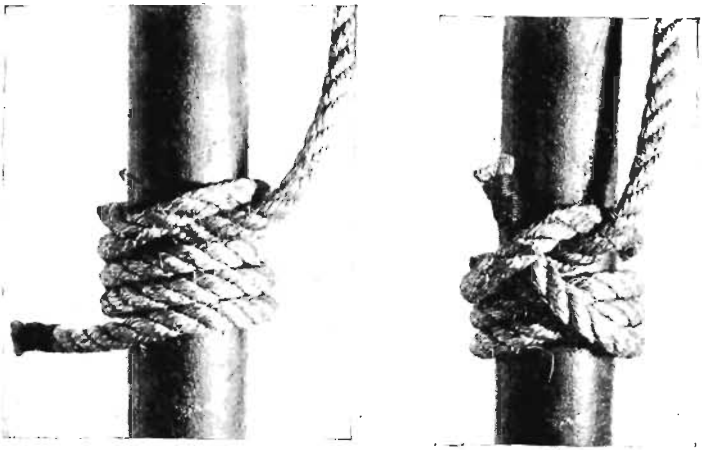
PLATE XXVIII.—Clove Hitch.

31. **Well Pipe Hitches:** For fastening a rope to a pipe.



1 2

First Method



1 2

Second Method

PLATE XXIX.—Well Pipe Hitches.

32. **Blackwall Hitch:** After it is drawn tight the user can pull on the long end. For fastening a rope to a hook.

PLATE XXX.—Blackwall Hitch.

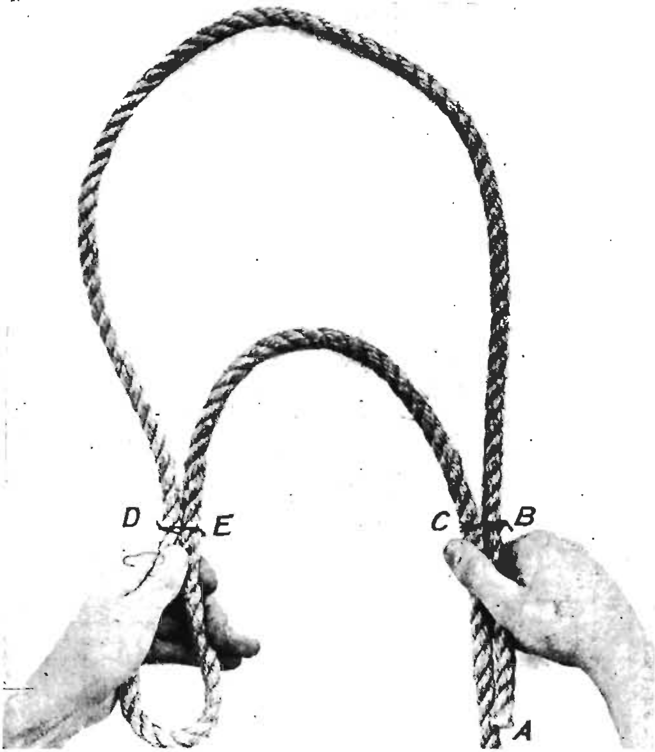
HALTERS

33. **Non-adjustable Halter:** This type of halter is especially adapted for use on horses and hornless cattle.

DIMENSIONS FOR NON-ADJUSTABLE HALTER[1]

Animal.	Diameter of Rope.	Total Length of Rope.	Distance.				Length Left for Lead.
			A–B	*B–D*	*D E*	*E–C*	
	In.	Ft.	In.	In.	In.	In.	Ft.
Large horse	$\frac{5}{8}$	15	7	44	·19	18	$6\frac{1}{2}$
Medium horse	$\frac{1}{2}$	14	6	40	17	16	$6\frac{1}{2}$
Small horse	$\frac{1}{2}$	13	6	36	16	14	6
Large cattle	$\frac{1}{2}$	$12\frac{1}{2}$	6	34	14	15	6
Medium cattle	$\frac{3}{8}$	12	5	32	12	13	6
Sheep and calves	$\frac{1}{4}$	8	4	18	8	8	4

[1] Minnesota Bulletin 136.



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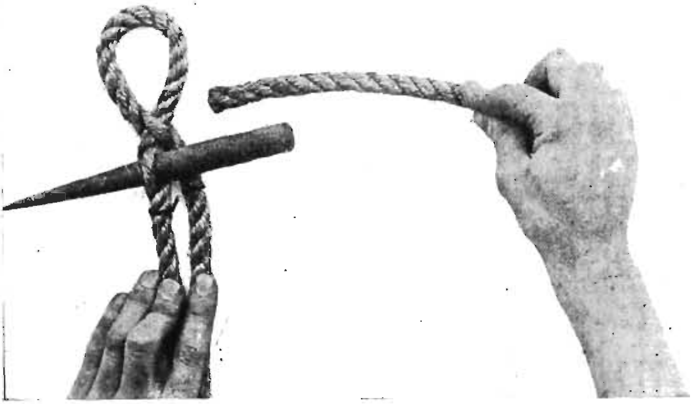

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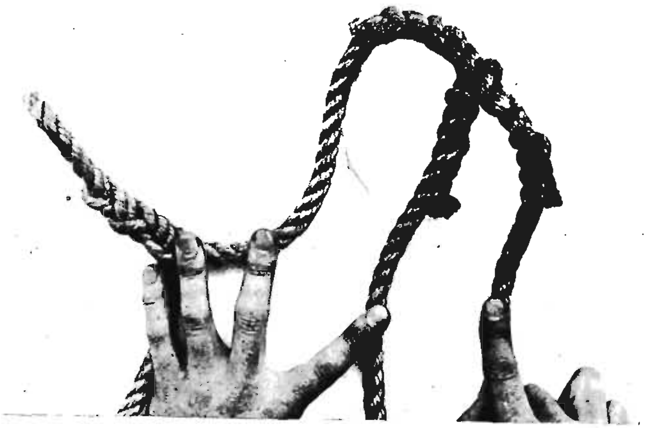
PLATE XXXI.—Non-adjustable Halter.

3



4

PLATE XXXI.—Non-adjustable Halter. *(Continued.)*

5

PLATE XXXI.—Non-adjustable Halter. (*Continued.*)

34. **Adjustable halter:** This type can be used for all kinds of stock, but is especially adapted for use on horned cattle.

DIMENSIONS FOR ADJUSTABLE HALTER[1]

Animal.	Diameter.	Total Length.	Distance from A to B.[2]	Length Left for Lead.
	In.	Ft.	In.	Ft.
Large cattle.....	$\frac{1}{2}$	12	18	6
Medium cattle...	$\frac{3}{8}$	$11\frac{1}{2}$	16	6
Small cattle......	$\frac{3}{8}$	11	14	6
Calves and sheep.	$\frac{1}{4}$	$7\frac{1}{2}$	10	4

[1] Minnesota Bulletin 136. [2] See p. 124.

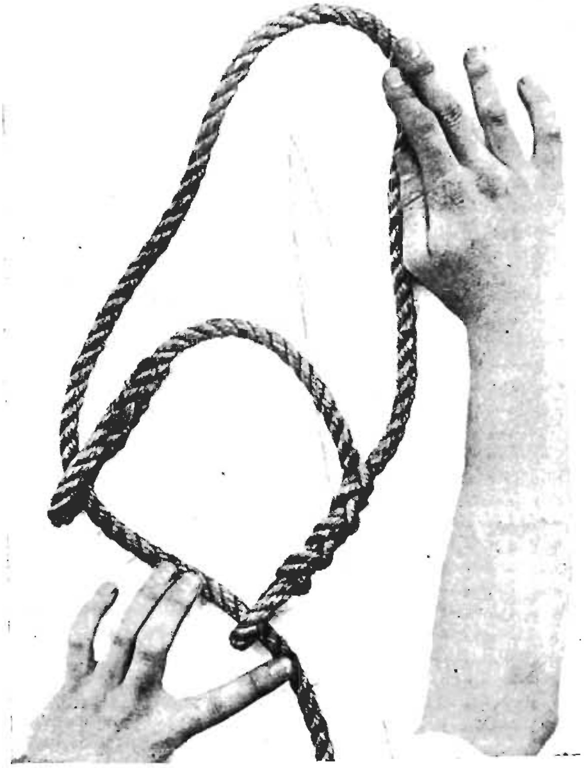
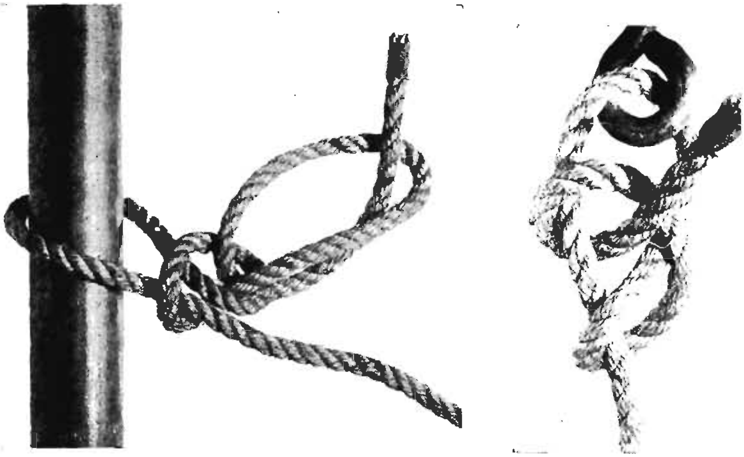


PLATE XXXII.—Adjustable Halter.

35. **Halter Ties:** The bow-and-slip-knot type is shown by the first method, Plate 33. It is very easily made, holds securely, and is easily untied. The non-slipping type is shown by the second method.

For fastening halter or hitching ropes to posts or rings.



First Method Second Method

PLATE XXXIII.—Halter Ties.

SPLICES

36. The Long Splice: Count off sixteen turns from the ends to be spliced and mark by tying a string around the rope at these points.

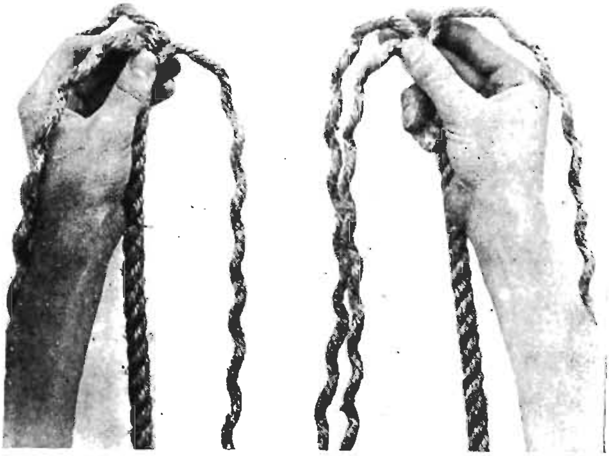


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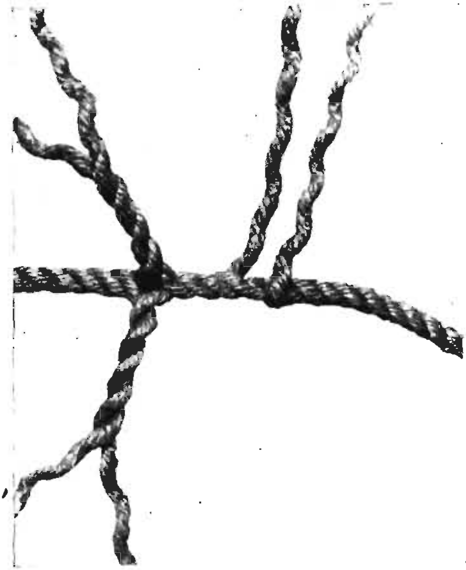
PLATE XXXIV.—The Long Splice.



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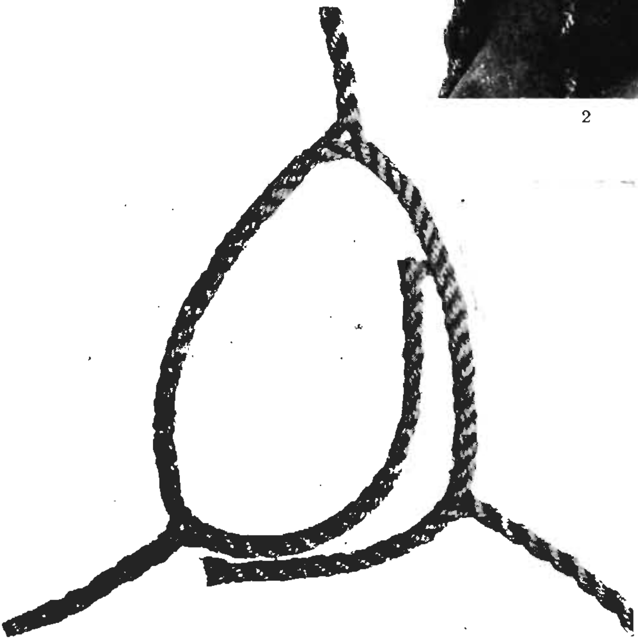
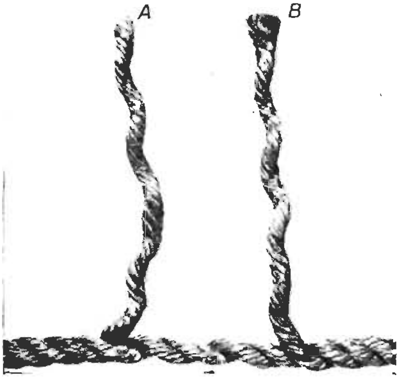


4

Plate XXXIV.—The Long Splice. (*Continued.*)

Be sure that (*a*) the ends of the ropes are forced closely together when beginning the splice; (*b*) the strand being inlaid is kept twisted very tightly, and (*c*) as one strand is unlaid, the other is inlaid in its place immediately.



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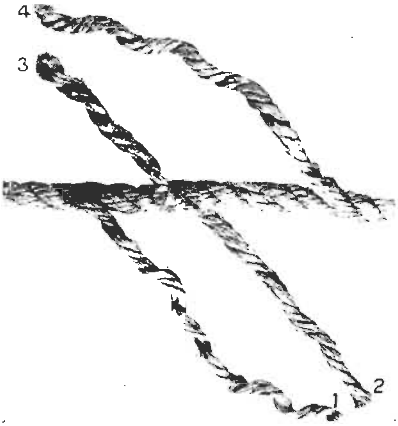

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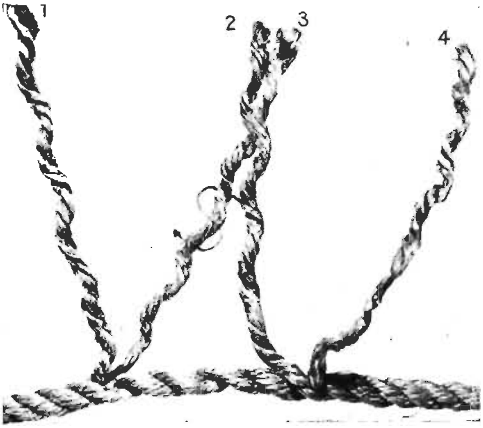

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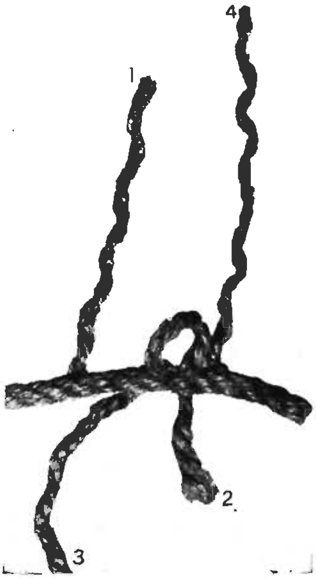
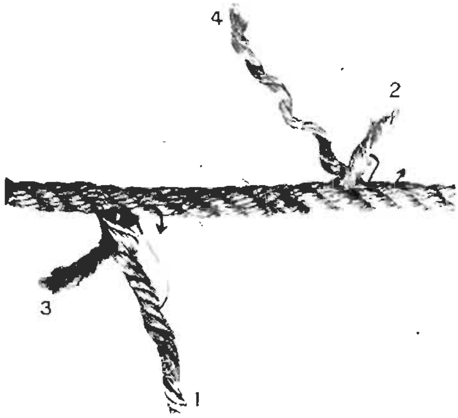
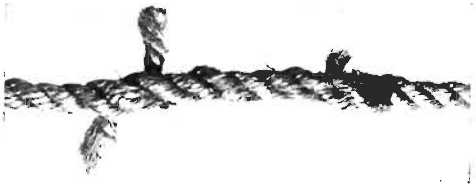


8

Plate XXXIV.—The Long Splice. (*Continued.*)

In making a long splice with a four-strand rope, count off twenty-two turns. With this rope there are four pairs of strands instead of three pairs.





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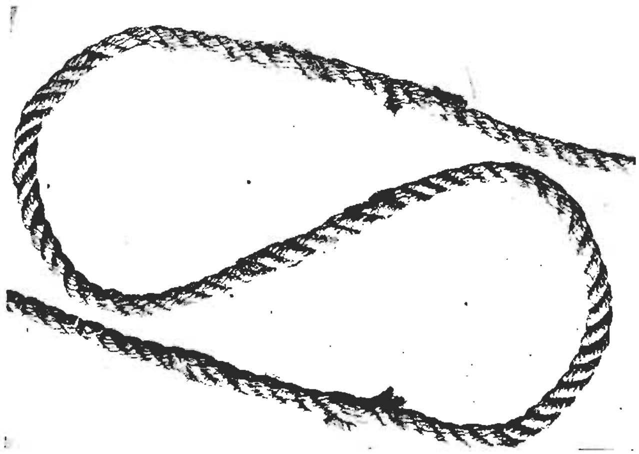

11

PLATE XXXIV.—The Long Splice. (*Continued.*)

EXERCISE 1*

Knot Slippage

TAKING one knot (specified by the instructor) at a time, pull it tight, mark the rope each side of the knot with a cord, and measure the distance between the cords. The ends of the ropes should be tied with a midshipman's hitch. Increase the pull to three-fourths of the safe load and measure the distance again. As the pull is still increased measure the distance frequently, as the knot may give way at any time.

Tabulate the data. Include size and kind of rope, kind of knot, slippage in inches or hundredths of inches, and ease with which knots could be untied.

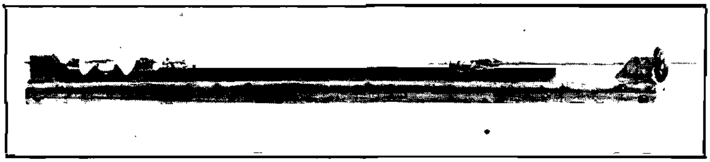

PLATE XXXV.—Device for Testing Rope.

EXERCISE 2

Strength of Knots

TEST several knots (specified by instructor) with the indicating dynamometer. The strain on the rope should be increased evenly until the knot breaks. See note, Ex. 1.

Tabulate the data. Include size and kind of rope, kind of knot, and breaking strength of knot.

* These tests will be made with an indicating dynamometer equipped with a maximum needle. The instrument must be arranged so that it will be jarred but very little when the knot or rope breaks. A device similar to the one shown in Plate XXXV can be used in making the test, or a block and tackle will do for increasing the pull on the rope. The latter method has the disadvantage of uneven loading. In all these tests note the degree of ease with which the different knots and hitches can be untied.

EXERCISE 3

Breaking Strength of Splices

Make four tests of each size of rope obtained from the instructor. Fasten at each end by means of the midshipman's hitch which is nearly as strong as the rope. Increase the strain on the rope steadily until the rope breaks. See note, Ex. 1.

Tabulate the data. Include the size and kind of rope, and the breaking strength of splice.

Make another table combining the data obtained in Ex. 2 and 3.

EXERCISE 4

Slippage of Hitches

This exercise is similar to Ex. 1, and should be performed in the same manner. The data should also include the size of pipe to which the hitch is attached. The pull on the hitch can be at right angles or parallel to the pipe to which the hitch is attached. The direction of the pull will depend upon the use to which the hitch is commonly put.

Block and Tackle

37. **Blocks:** The parts of a block are: the shell or frame; the sheave upon which the rope runs; and the pin upon which the sheave turns in the shell. To the shell is attached a hook. At the other end of the shell a becket is often fastened. See Plate 36.

38. **Tackles:** A tackle is a system of ropes and pulley blocks, and is used for lowering, raising, or moving forward heavy objects.

39. **Mechanical Advantage of Blocks:** Rule 1, the power is multiplied by the number of strands of rope less one, when the power strand acts downward. Rule 2, the power is multiplied by the number of strands supporting the weight.

These rules give the mechanical advantage if friction is neglected. The amount of friction, of course, increases with the number of sheaves and depends, to a great extent, on the

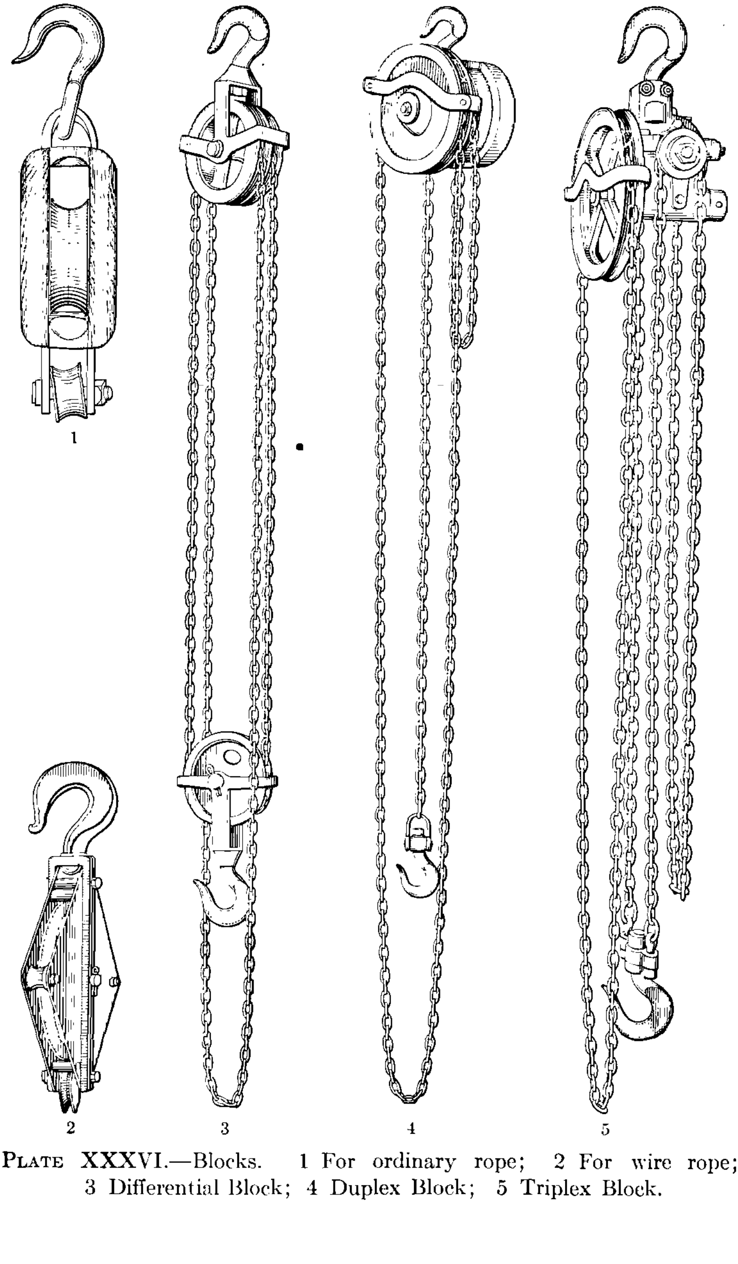

PLATE XXXVI.—Blocks. 1 For ordinary rope; 2 For wire rope; 3 Differential Block; 4 Duplex Block; 5 Triplex Block.

lubrication of the pin. The efficiency varies from 96 to 60 per cent for $1\frac{1}{4}$–2 inch manila rope.*

40. **Ordering Blocks:** Give the purpose for which the blocks will be used. For very heavy work, such as stump pulling, railroad and bridge work, extra strong blocks with roller bearings may be had. Steel blocks can also be obtained. Blocks used with wire rope are constructed differently from those intended for ordinary rope as shown in Plate XXXVI.

Always specify the size of rope, number of sheaves, and whether or not the becket is desired.

Practical Problems

1. (*a*) A load of 100 pounds is to be lifted by a block and tackle. Give the size of manila and of sisal rope necessary.

(*b*) What is the safe load and breaking strength of these sizes?

2. A $\frac{1}{2}$-inch sisal rope has been used in the open until it has greatly weakened. What is a good estimate of its safe load?

3. What kind of rope and what size should be used for the hay rope in a barn? Explain.

4. Draw a sketch of a block and tackle, having two sheaves and a becket on the lower pulley, and three sheaves on the upper pulley.

5. The same as 4, except with 2 sheaves on the upper pulley, and 3 sheaves and a becket on the lower pulley.

6. What is the difference between 4 and 5 in (*a*) power advantage; (*b*) direction of power strand?

7. (*a*) Show by a sketch a 6-strand block and tackle.

(*b*) What power is necessary to lift a weight of 400 pounds by this arrangement if friction is neglected?

8. On a 7-strand block and tackle, power strand acting downward, what power is required to lift 300 pounds, if friction is neglected?

* Kent's "Mechanical Engineer's Handbook," 9th edition, p. 1182.

9. On a 6-strand block and tackle, power strand acting upward, what power is required to lift 250 pounds, neglecting friction?

10. In moving a house by a block and tackle, how should the system be arranged with respect to position of becket and direction of motion of power strand? Show this by a sketch.

11. A block and tackle consists of a 3-sheave pulley above and a 2-sheave pulley with becket below. If the efficiency is 72 per cent what force is necessary to lift 520 pounds?

12. A block and tackle consists of a 2-sheave pulley with becket above and a 3-sheave pulley below. If the efficiency is 72 per cent, what force is necessary to lift 215 pounds?

13. Write an order for the block and tackle used in Problem 11 if the load is raised 10 feet.

14. Explain the difference between differential, duplex, and triplex blocks.

CHAPTER II

BELTS

41. **Materials:** Belts are made of leather, rubber, and canvas. Each material has advantages and disadvantages. Leather and rubber belts are used chiefly indoors, and canvas belts are better for outdoor work. Canvas belting withstands the weather conditions, is comparatively cheap, but will stretch and contract.*

42. **Horse-power of Belts:** The difference in tension between the tight side and the slack side of a belt in motion is called the effectual tension, which is frequently considered to be 33 pounds per inch width of belt.

Then $H.P. = \frac{VW}{1000}$, V being the velocity in feet per minute of the belt, and W the width of the belt in inches. This formula is for a single-ply leather belt.

Four-ply rubber and canvas belts are usually considered equal to a single-ply leather belt. A double-ply leather belt will transmit $\frac{10}{7}$ as much as a single ply leather. Another rule which gives a slightly different result is: "Multiply diameter of pulley in inches by its number of revolutions per minute and this product by width of the belt in inches; divide this product by 3300 for single belting, or by 2100 for double belting." †

43. **To Find the Length of Belt Required for Two Given Pulleys:** "When the length cannot be measured directly by a tapeline, the following approximate rule may be used: add

* For further discussion of advantages and disadvantages of belts, refer to Kent's "Mechanical Engineer's Pocketbook," and textbooks on farm machinery.

† N. G. E. A. Data Sheet, page 17, Volume I.

the diameter of the two pulleys together, divide the sum by 2, multiply the quotient by $3\frac{1}{4}$ and add the product to twice the distance between the centers of the shafts." *

44. **Distance Between Pulleys:** For inside work, "A general rule may be stated thus: Where narrow belts are to be run over small pulleys, 15 feet is a good average, the belt having a sag of $1\frac{1}{2}$ to 2 inches. For larger belts, working on larger pulleys, a distance of 20 to 25 feet does well with a sag of $2\frac{1}{2}$ to 4 inches. For main belts working on very large pulleys, the distance should be 25 to 30 feet, the belts working well with a sag of 4 to 5 inches." †

Conditions are different with ensilage cutters and threshing machines. On account of the fire hazard accompanying the use of a steam tractor, the distance between main pulleys should be from 120 to 160 feet. If a gas tractor is used, the fire hazard may be considered negligible. In this case 50 feet between pulleys is satisfactory. A factor not to be overlooked is the increase of belt slippage as this distance becomes less. If the pulleys are 50 feet or more apart, the weight of the belt makes it unnecessary to operate with a tight belt.

45. **Belt Dressings:** These should never be used unless the belt becomes dry and husky (referring to leather belts). Neatsfoot oil can be applied advantageously. The belt should first be moistened a little. Prepared castor oil dressings are good.

It is a good practice to clean and grease leather belts every six months to give the grain side a soft, adhering surface. The following dressing is recommended. "Take 2 parts of beef tallow to 1 part of cod liver oil (by weight). Melt the tallow and allow it to cool until it will not burn the finger; then add the cod liver oil and stir until cooled. A light coat of this mixture should be applied to the driving side of the belt after it has been cleaned." ‡

* Kent's "Mechanical Engineer's Pocketbook," 9th edition, p. 1148.

† Ibid., p. 1149.

‡ "Machinery's Handbook," 5th edition, p. 706.

The use of soap and resin to prevent a belt from slipping is a bad practice, as both are injurious to the belt.

46. **Care of Belts:** The smooth side, which is the hair or grain side of leather belts, should run next to the pulley. The flesh side is more flexible and therefore should be on the outside. On rubber belts the side with the white strip in the center should always be placed out.

Leather belts must be protected against water, steam, dripping oil, and temperatures above 130° F.

Rubber belts must be protected from oil and grease. If they should slip (not a frequent occurrence) on account of dust, or some other cause, they can be lightly moistened on the side next the pulley with boiled linseed-oil.

Good dressings for canvas belts are hard to obtain. Many preparations either harden the belt or make the belts sticky. However, some of the commercial preparations are excellent. Ordinary linseed-oil paint can be used to advantage when the belt begins to fray.

With horizontal, or nearly horizontal, belts it is desirable to have the under side drive, for then the sag side is above and as a result more of the belt comes into contact with the pulleys.

47. **Arrangement of Belts and Pulleys:** It is desirable to have the angle between the belt and the floor not greater than 45 degrees. Shafting and machinery should be arranged so that the belts will run off the pulleys in opposite directions. The pulleys should be a trifle wider than the belts and should be located close to the shaft hangers. The motion of driving should not be against but with the laps in the belt.

48. **Lacing Belts:** To attach the ends of a belt together, the following methods are used: cement splices, wire lacing, patent fasteners, and leather lacing.

For a cement splice, the length of lap should be from 5 to 6 inches for 1 to 4-inch belts; from 1 to 2 inches more than the width for 5 to 9-inch belts; and the same as the width for 10 to 18-inch belts. The ends should be dressed to a feather edge. This is easily accomplished if the ends of the belt are tacked to a small board.

A perfect fit is essential. When completed the splice should have the same thickness as the original belt. After the cement has been spread thinly over the two surfaces, the ends should be put together carefully and then put under pressure. The pressure can be applied by nailing a board over the splice or using a clamp. The belt can be used after the splice has been allowed to set for twenty-four hours.

Nothing but the best belt cement should be used. Any first-class belting house can furnish this and is usually the best place to obtain it.

Wire lacing is commonly used for factory belts. Rather narrow belts passing around large pulleys are frequently spliced with wire.

The *cement splice is used mostly on leather* belts, infrequently on rubber belts. This splice is very satisfactory whenever a smooth running belt is desired and it is particularly well adapted for leather belts operating on small pulleys.

Patent belt fasteners can be obtained in many forms. They are used extensively for leather and rubber belting, as they are more convenient to use than lacing and take less time to put on. Patent belt fasteners, however, are not carried in stock by the dealer as frequently as lacing.

Leather or rawhide lacing from $\frac{3}{16}$ to $\frac{3}{4}$ inch wide is the material most commonly used. To lace a leather or a rubber belt, the ends should first be cut off square, then, at equal distances apart, holes punched with an oval punch so that the long diameter of the hole is parallel to the side of the belt. If it is a canvas belt, an awl is necessary, as a punch will cut off many strands, thus weakening the belt.

The holes can be placed in a single or double row, depending upon the size of belt and nature of work.

For the ordinary lacing start in the center and work both ways, equal tension being kept on each side. **The laces should never be crossed on the pulley side of the belt.**

Hinged lacing can be put in by first beveling the ends of the belt slightly to prevent the sharp edges cutting the lacing and then following the method shown in Fig. 2, Plate XXXVII.

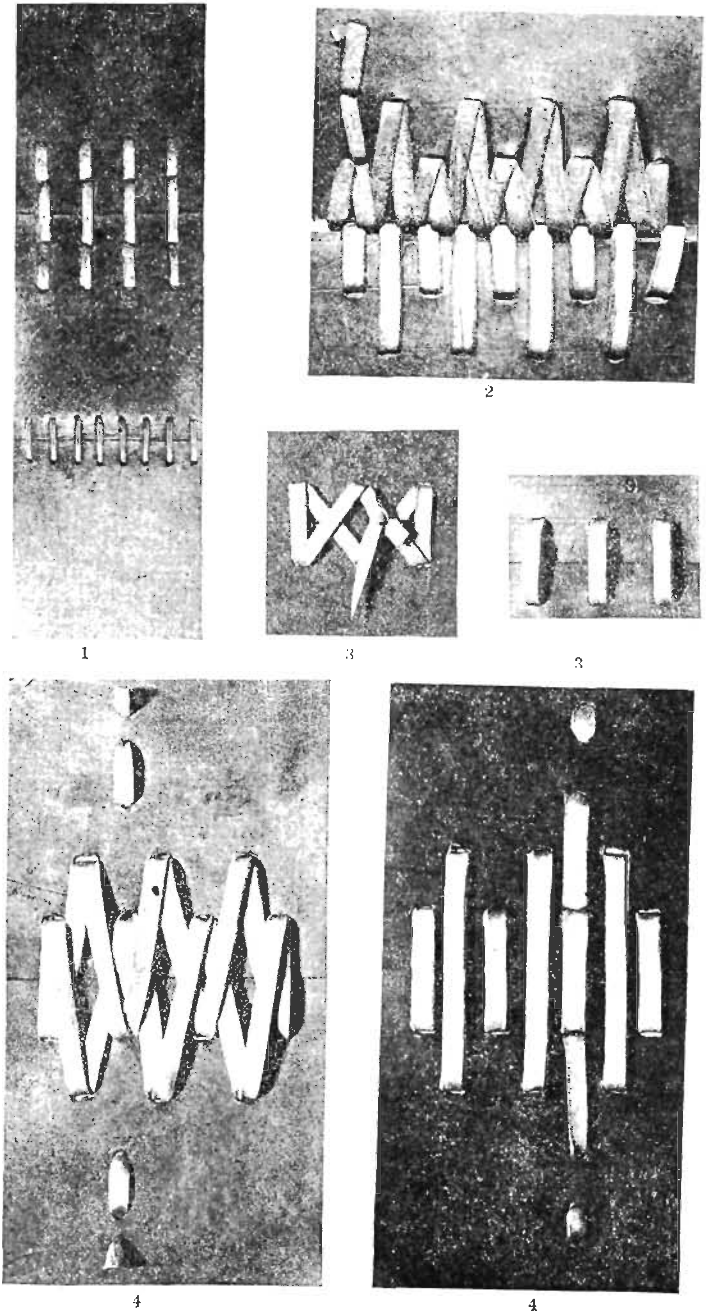

PLATE XXXVII.—Belt Laces.

BELT LACES AND HOLES FOR LACED JOINTS[1]

Width of Belt, Inches.	Width of Lace, Inches.	No. of Holes.	Distance of Holes from End.		Width of Belt, Inches.	Width of Lace, Inches.	No. of Holes.	Distance of Holes from End.	
			First Row, Inches.	Second Row, Inches.				First Row, Inches.	Second Row, Inches.
1 –$1\frac{3}{4}$	$\frac{1}{4}$	2 or 3	$\frac{3}{8}$	....	6	$\frac{3}{8}$	9	$\frac{3}{4}$	$1\frac{1}{4}$
2 –$2\frac{1}{2}$	$\frac{5}{16}$	3	$\frac{3}{8}$	$\frac{3}{4}$	8	$\frac{1}{2}$	11	$\frac{3}{4}$	$1\frac{3}{8}$
$2\frac{3}{4}$–$3\frac{1}{4}$	$\frac{5}{16}$	5	$\frac{1}{2}$	1	10	$\frac{1}{2}$	13	1	$1\frac{3}{4}$
$3\frac{1}{2}$–$4\frac{1}{2}$	$\frac{3}{8}$	5	$\frac{5}{8}$	$1\frac{1}{8}$	12	$\frac{1}{2}$	15	1	$1\frac{3}{4}$
5	$\frac{3}{8}$	7	$\frac{5}{8}$	$1\frac{1}{8}$	14	$\frac{1}{2}$	17	$1\frac{1}{4}$	2

[1] "Machinery's Handbook," p. 706.

The hinge lace is very good for canvas belts and for all belts passing over idlers.

EXERCISE 1

Splicing

In this exercise several belts will be spliced as shown in Plate XXXVII. When the splices have been completed, a tag bearing the student's name, section, and date should be attached and the work handed in.

EXERCISE 2

Cement Splice

Obtain belt ends, *small board, hammer, tacks, and cement* from the tool room. Make a cement splice as described in Article 48.

Attach a tag bearing your name, section, and date to one end of the belt ends, and hand in.

Practical Problems

1. Why is it a poor practice to set the source of power too close to the driven machine?

2. How much horse-power will a 6-inch single-ply leather

belt transmit if the effectual tension equals 33 pounds per inch, and if the 12-inch driving pulley makes 550 r.p.m.?

3. How much horse-power will a 4-inch, 4-ply rubber belt transmit if the effectual tension equals 33 pounds per inch, and if the 6-inch driving pulley makes 360 r.p.m.?

4. How much horse-power will a 5-inch 4-ply rubber belt transmit if the effectual tension equals 33 pounds per inch and if the 10-inch driving pulley makes 400 r.p.m.?

5. Same as 2, except that effectual tension equals 45 pounds per inch of width.

6. Two shafts are 14 feet apart. On one shaft is a 10-inch pulley, and on the other a 7-inch pulley. How long should the belt be?

7. Same as 8, only shafts are 10 feet apart and the pulleys are 6 inches and 8 inches in diameter respectively.

8. (*a*) Choose a belt to be used in driving a 36–60 separator. The cylinder pulley is $13\frac{1}{2}$ inches in diameter and $9\frac{1}{4}$ inches wide. A steam tractor will furnish the power.

(*b*) What is the linear velocity of this belt in feet per minute when the cylinder is revolving 1000 revolutions per minute?

(*c*) What horse-power is the belt transmitting if the effectual tension equals 33 pounds per inch?

CHAPTER III

BABBITTING

49. **Apparatus:** The following equipment is necessary: a fire pot, a medium-sized ladle, babbitt metal, a hammer, a diamond-point chisel, a round-nose chisel, liners (cardboard), yellow clay or putty, gasoline, and waste. A box containing these can be obtained from the tool room.

50. **Babbitt Metal:** This is a soft alloy of varying composition. As found in the open market some is good, some worthless. Tin, lead, and antimony are found in most of the anti-friction metals sold under the name of babbitt metal, although very little genuine babbitt metal is sold that is made strictly according to the original formula. The better grades of babbitt contain copper.

51. **Preparing the Box:** After all old babbitt is removed, usually by chipping, the box should be cleaned with gasoline. If the box is not perfectly clean and dry, gas will be formed from the grease or moisture when the hot metal is poured in. This will cause either the formation of blowholes or the blowing out of the babbitt. Sometimes a drop of resin is added to prevent blowing. The parts of the box should be warmed before the babbitt metal is poured, especially in frosty weather.

To babbitt a split box, place strips of cardboard or sheet iron between the halves of the box and against the shaft. This will divide the babbitt. Cut 4 or 6 V-shaped notches in the edge of the cardboard or sheet-iron that fits against the shaft. To allow for wear, insert three or four thicknesses of cardboard, called "liners," between the halves of the box, but, if possible, use the original liners with one or two additional. Bolt the cap on securely.

Now block up the shaft until it is in the center of the box. Make collars of the cardboard to fit the shaft at each

end of the box. Place putty or stiff clay around the outside of the cardboard collars. This will make certain that no babbitt can run out. If stiff clay is used, care should be exercised in keeping it as dry as possible. If it is too wet, steam will form when the babbitt is poured into the box and a blowout will occur, sometimes injuring the worker.

Be sure to leave a large air-hole extending up above the box. If there are two oil holes, one may be used for this purpose. If a hole must be left at one end of the box, make a small funnel of clay around it. On the larger boxes leave a hole at each end of the box. Make a funnel around the pouring hole also. This should extend a little above the box to give pressure to the babbitt and to allow the metal to fill in as it shrinks in cooling.

By stopping the oil hole with a wooden plug, a hole will be left through the babbitt so that it will not be necessary to drill one later.

If the babbitt is hard to pour, a few drops of kerosene should be placed in the box.

The split box is now ready for pouring.

To babbitt a solid box the procedure is similar. Cover the shaft with one thickness of writing paper. Smooth the paper and fasten the lapped ends with mucilage or wrap a cord around the shaft a few times, making certain that no parts of the cord extend to the outside of the box. The space occupied by the cord will serve as oil grooves. If paper is not used, the metal may shrink so much in cooling as to make it impossible to turn the shaft. By using paper and then removing it, it is found that the shaft is just loose enough to run well.

Instead of paper, a small shaft may be covered with soot, chalk, graphite, or soap to prevent sticking.

Prepare the ends and holes as described under split boxes.

The solid box is now ready for pouring.

52. **Heating the Babbitt:** Overheating the metal or allowing it to remain in a molten state is injurious. The metal, therefore, should be heated until it is just hot enough to run

freely. The best time to pour is when the metal is just hot enough to char a white pine stick or when the metal commences to change from a silvery tinge to a yellowish tinge.

53. **Pouring the Babbitt:** When the metal is ready, pour it continuously and rapidly until it appears at the air-holes.

A split box is sometimes poured half at a time instead of as described in Article 51. Pour the lower half first. Place solid liners between the two halves to prevent adhesion and to allow for wear.

54. **Finishing the Box:** If it is a split box, separate the halves of the box, when cool enough to handle, by driving a chisel between them. With a round-nose chisel trim the sharp edges and cut oil grooves in the shape of a letter X crossing at the oil holes. Do not extend oil grooves to the edges of the babbitt. To make the shaft fit properly, scrape and polish the babbitt until the shaft fits everywhere. By coating the shaft with lampblack and lard oil very thinly and then moving the box back and forth on the shaft, the highest projections can be discovered. Scrape these down and repeat the process.

Scrapers are made in various shapes and sizes for different kinds and sizes of bearings. Those needed can be obtained from the tool-room.

To finish the solid box merely remove the paper and cord, and open the oil hole.

EXERCISE 1

Babbitting a Split Box

OBTAIN apparatus named in Article 49. Babbitt a split box as described in Arts. 51 to 53 inclusive. When through, show babbitted box to instructor.

EXERCISE 2

Babbitting a Solid Box

THIS exercise is similar to Ex. 1, except that a solid box is babbitted instead of a split box.

When through, show box to instructor.

EXERCISE 3

Fitting and Testing

THE babbitted boxes of Exercises 1 and 2 are to be prepared for service. Read Article 54. Obtain scrapers from the tool room and fit the box. When through, show the work to the instructor.

Test the box by running the shaft at high speed for at least ten minutes to see if the box will heat. Should the box heat, either the box must be rescraped, or liners must be placed between the halves of the box. Which is necessary depends upon the source of the trouble. Repeat the test.

CHAPTER IV

SOLDERING

55. **Apparatus and Materials:** The following equipment is necessary: A furnace, soldering coppers, solder, and flux.

Small gasoline furnaces arranged for holding at least two coppers at one time are commonly used for this purpose.

Soldering coppers, in the 3- and 4-pound sizes, are the ones most used by the tinners. By 3-pound coppers is meant that a pair weighs 3 pounds. If the copper is too small, heat is lost so rapidly that it is difficult to do good work.

Solder is a fusible alloy of two or more metals. Soft solders consist chiefly of lead and tin and in varying proportions. The ordinary tinner's form is made of one part lead and one part tin and is commonly called "half and half." Another grade frequently used consists of two parts of lead and one part of tin. Hard soldering is generally known as brazing and is used more for special purposes; for that reason it will not be discussed here.

Flux is used to aid in keeping clean the surfaces to be soldered, and to prevent the formation of oxides during soldering. A very common form of flux, zinc chloride, can be prepared by dissolving small pieces of zinc in hydrochloric (muriatic) acid.* The zinc should be added a little at a time to a small, wide-mouthed bottle about half full of hydrochloric acid, until there remains some zinc undissolved. Care should be taken not to add the zinc too rapidly, or the heat generated by the chemical reaction might be sufficient to break the bottle. The flux or soldering fluid should be prepared one or two

* CAUTION.—Care must be used in the preparation of this solution, for the acid is injurious to the tools.

days before needed. Powdered resin is also a good flux. The two fluxes mentioned can be used for almost all kinds of ordinary soldering. Hydrochloric acid is recommended by some for use in soldering galvanized steel and sal-ammoniac for iron and steel.

56. **Tinning the Copper:** Two methods can be used. Clean and shape up the end with a file. "Heat the copper until it will a little more than melt the solder from the bar. Coat the copper from the point back by dipping into the soldering fluid and then rubbing on the bar of solder. Wipe the copper with a piece of damp waste as soon as tinned, or dip in sal-ammoniac water and then wipe." *

The second method is as follows: "Place a small piece of solder in the depression of a brick that has been slightly hollowed out on one side. Provide sal-ammoniac in either the pulverized or crystal form. Many prefer the pulverized form. Heat the copper to a temperature considerably higher than that required for soldering, or nearly at red heat. Remove the copper from the heating pot and clean the four tapering sides rapidly and thoroughly with an old file. Coat the point of the copper with sal-ammoniac for some distance back, either rubbing it on a piece of the crystal or in some of the pulverized sal-ammoniac placed on top of the brick. As soon as the point is thoroughly coated on all sides, a condition which can be judged by the change in color, rub it over the piece of solder previously placed in the hollow of the brick. If the solder does not appear to stick to the copper and coat it properly, use sal-ammoniac again as already described. While trying to coat the copper with solder rub it on the brick with some force. This tends to clean it further and causes the solder to adhere. The object of using the brick is to hold a small amount of solder and permit it to be used economically, as well as to clean the copper as the solder is being applied in tinning. Wipe the copper with a piece of damp waste as soon as tinned." †

* R. E. Wiseman, Kansas State Agricultural College.

† A. H. Gilbert, Purdue University.

57. **Preparing to Solder:** Clean perfectly all parts to be soldered. Remove oxides by filing or scraping to insure a clean surface. Apply flux (see Article 55) with a swab to the spot where the solder is to be applied.

In the meantime, heat the coppers just hot enough to melt the solder easily. If the coppers are heated to too high a temperature, the tinning will melt off. If the coppers are used when too cold, it will be found difficult to make the solder stick with the result that a smooth, neat job will be impossible.

58. **Soldering:** Wipe the copper on a piece of damp waste each time it is taken from the fire or dip in sal-ammoniac water. Hold together securely the parts to be soldered. Deposit the solder in a thin, smooth layer by drawing the copper along the seam. Do not apply pressure to the point, as this will weaken it. The copper will only hold a small amount of solder. By touching the bar of solder enough will come off for use. Remember that solder is needed only where the edges come together. Thorough knowledge of the proper temperature of the copper and of the behavior of the solder when the copper is either too hot or too cold can be obtained only by practice.

Clean parts soldered.

EXERCISE 1

Tinning the Coppers

OBTAIN the coppers and materials from the tool room. The coppers can be tinned as described in Article 56.

EXERCISE 2

Soldering Holes

OBTAIN a piece of tin full of holes and a soldering outfit from the tool room. When the holes are soldered, show the work to the instructor.

EXERCISE 3

Soldering Edges

OBTAIN two pieces of tin and a soldering outfit. Solder edges together to make one piece.

EXERCISE 4

Practice in Soldering

THIS exercise will consist of special work which will be assigned by the instructor.

CHAPTER V

PIPE CUTTING

59. **Appliances:** The following equipment is found desirable: stocks, dies, a pipe cutter, a pipe vise, and two pipe wrenches.

The thread used in pipes and fittings is different from that used on bolts, so the stocks and dies are different. The threads on a bolt are straight, that is cut on a cylinder, and the threads on a pipe are tapering, so that a tight joint can be much more easily obtained. The United States Standard Thread is usually used on machine bolts, while the Briggs Thread is used on pipes. The following tables give some of the dimensions of the two systems of threads.

UNITED STATES STANDARD THREAD—NUMBER OF THREADS PER INCH CORRESPONDING TO A GIVEN DIAMETER [1]

Diameter.	Threads per Inch.	Diameter at Root of Thread.
$\frac{1}{4}$	20	0.1850
$\frac{5}{16}$	18	0.2403
$\frac{3}{8}$	16	0.2938
$\frac{7}{16}$	14	0.3447
$\frac{1}{2}$	13	0.4001
$\frac{9}{16}$	12	0.4542
$\frac{5}{8}$	11	0.5069
$\frac{11}{16}$	11	0.5694
$\frac{3}{4}$	10	0.6201
$\frac{13}{16}$	10	0.6826
$\frac{7}{8}$	9	0.7307
$\frac{15}{16}$	9	0.7932
1	8	0.8376

[1] "Machinery's Handbook," pp. 1002.

BRIGGS PIPE THREAD AND GAGE DIMENSIONS[1]

Diameter of Pipe.			No. of Threads per Inch.	Diameter at End of Pipe.
Nominal Inside.	Actual Inside.	Actual Outside.		
3/8	0.494	0.665	18	0.656
1/2	0.623	0.840	14	0.815
3/4	0.824	1.050	14	1.025
1	1.048	1.315	11½	1.283
1¼	1.380	1.660	11½	1.626
1½	1.610	1.900	11½	1.866
2	2.067	2.375	11½	2.339
2½	2.468	2.875	8	2.819
3	3.067	3.500	8	3.441
3½	3.548	4.000	8	3.938
4	4.026	4.500	8	4.434

[1] "Machinery's Handbook," pp. 1008.

Pipe cutters are of two general types, one-cutter wheel and three-cutter wheels. The first type is easily started, leaves no burr at the end of the pipe, but must swing through an entire circle. The second type can be used in a limited space and works rapidly; care is necessary in getting the cut started straight, and a burr is left that must be removed by filing before the thread can be started.

60. **Fittings:** Plate XXXVIII shows the fittings in common use. It must always be remembered that the sizes of pipe given up to, and including, 10-inch pipe, are nominal and refer to the inside diameter.

61. **Pipe Cements and Lubricants:** Plumbago and cylinder oil is a very satisfactory lubricant for pipe joints or for any screwed joints. Litharge and glycerine is a mixture which gets very hard and is often used for the same purpose.

The following cements are used for pipe joints: "A mixture of red lead with linseed oil in a thick paste. Diamond cement may be prepared by slowly stirring into 40 parts of linseed oil the following ingredients in the order given: litharge, 30 parts; slaked lime, 10 parts; whiting, 20 parts; graphite,

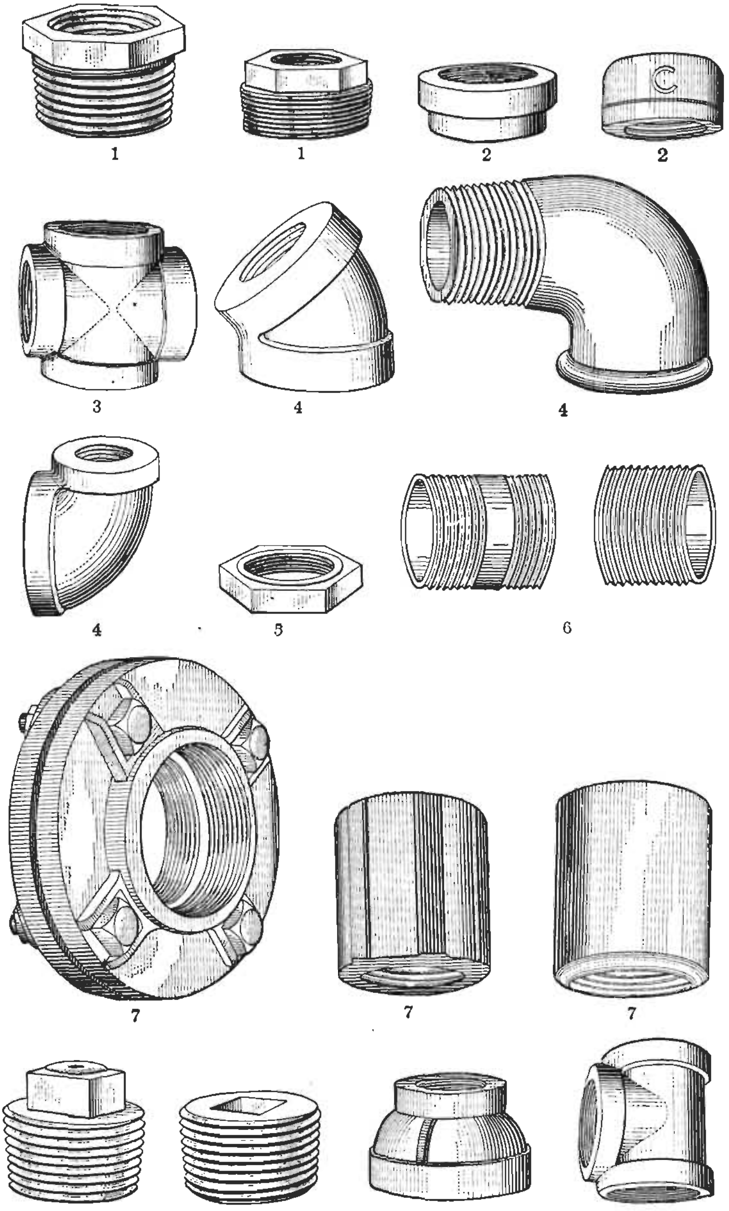

PLATE XXXVIII.—Pipe Fittings. 1 Bushings; 2 Caps; 3 Cross; 4 Elbows; 5 Lock Nut; 6 Nipples; 7 Pipe Unions; 8 Plugs; 9 Reducer; 10 Tee.

100 parts. It should be applied hot to the slightly roughened surface of the metal." *

62. **Cutting Pipe:** Mark with a file the place to be cut. Be careful to start the cutter in the file mark and not to move it to either side. To lighten the work and decrease the wear on the cutter wheel apply cutting oil or lard oil freely to the groove while cutting.

63. **Threading Pipe:** First remove by filing any burr that may be left by the cutter. Clamp pipe in vise so that the end is clear of the bench. Stand squarely in front of the end of the pipe and start the die, bushing side first. When starting the die exert considerable pressure and revolve it very slowly. Apply cutting oil or lard oil frequently.

Cut the threads until the end of the pipe is flush with the outside of the die. This is the common practice. The standard lengths of thread for cutting pipe can be found in any handbook giving pipe dimensions.

Remove die from pipe. To clean the threads of metal particles, strike the pipe a sharp blow just back of the threads with another piece of pipe or with a hammer while the pipe is still in the vise.

EXERCISE 1

Pipe Fitting

OBTAIN blue print, pipe fittings, and tools from the tool room. Follow directions on blue print in assembling pipes and fittings. Be careful not to use too large a wrench on a small pipe.

When the exercise is completed, show to the instructor for approval. If approved, clean all tools carefully, and wipe dry with waste. Return to tool room.

* "Mechanical Engineer's Handbook," p. 620.

THREAD CUTTING

EXERCISE 1

Threading Bolts

OBTAIN screw-plate set and six rods of various sizes from the tool room. The bolts are to be rethreaded so that nuts selected from a full assortment will fit properly. Oil die and bolt threads with a good grade of machine oil before and during threading.

When through, wipe threads and select nuts for each bolt. Show to the instructor for approval.

EXERCISE 2

Threading Nuts

SAME as Exercise 1, only six nuts are to be threaded instead of six bolts.

SEMESTER ASSIGNMENT

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